Gas Journal

NOVEMBER 28, 1934

Vol. 208. 86th Year No. 3732

Editorial Notes

Steaming in Horizontals

A CONSIDERABLE portion of the Report of the Director of Fuel Research, published last Monday with the Report of the Fuel Research Board for the year ended March 31 last, is devoted to steaming in horizontal retorts and re-circulation of waste gases through the settings. The information given brings the story told by Dr. F. S. Sinnatt in his William Young Memorial Lecture in 1933—supplemented by the paper by Mr. H. D. Madden and the Works Technical Staff of the Cardiff Gas Light and Coke Company last May—further up to date.

Dr. Sinnatt's Report indicates the extent of the interest aroused by the work at Cardiff and at the Fuel Research Station on increasing the thermal yield per ton of coal carbonized in horizontal retorts and also the throughput of the settings. Reference is made in this regard to investigations undertaken recently by the Gas Light and Coke Company and the Wandsworth and District Gas Company. At two of their works the former Company have experimented with re-circulation of waste gases through the settings. Without any increase in the combustion chamber temperatures, a greater throughput of coal by approximately 45% has been secured, though this was accompanied by an increase of 17% in the fuel used per ton of coal for heating the settings. In addition, the equivalent of 890 lbs. per ton of coal was used for driving the fans and working the necessary gas and air injectors. The value of this method of operating horizontal retorts is principally dependent upon the price of coke, as there is a point at which the cost of the additional fuel, including that for power purposes, exceeds the saving that can be effected in the reduced interest on the lower capital expenditure. However, the fact that a so greatly increased throughput can be obtained without material alteration to the plant installed is of importance, and it greatly enhances the flexibility of the horizontal retorting system.

Investigation by Gas Companies

THE Report mentions that for several months the complete carbonizing plant of horizontal retorts at one of the Gas Light and Coke Company's stations has been operating on steaming. The plant, which is carbonizing Durham coals at a rate of 500 tons a week, has confirmed the Fuel Research Station experiments. We may recall that at the Fuel Research Station, employing normal horizontal retorts with 12 cwt. charges, it has been found possible to introduce steam over the last three hours without marked influence on combustion chamber temperature. The result was to raise the yield of gas from 75 to 87 therms per ton—a result achieved without special methods of charging, though the retorts were "fairly full of coal." The outcome of the investigation by the Gas Light and Coke Company, we learn from the Report, has been so satisfactory that there is no intention of discontinuing steaming. The gas yield has been increased without difficulty by 6 therms per ton of coal, and combustion chamber temperatures have only had to be increased by a matter of 10° C.—from 1,360° to 1,370° C. The rate of scurf formation is definitely slower, but by lengthening slightly the periods between scurfing, the retorts have been maintained in a tight condition.

The Wandsworth Company started steaming horizontal retorts as long ago as June, 1933. Steaming in fourteen settings at the Sutton Works accounts for a 10% increase in gaseous volume and an increase in gas yield per ton of coal by 7 to 8 therms. At the Company's Mitcham Works the results have been even more satisfactory. There is evidently a great deal to be said in favour of steaming in horizontals, and Mr. Madden's original suggestion that the Fuel Research Board should investigate the problem has borne good fruit. Turning to the latest work of the Board, as outlined in the Report, we find many interesting observations. In the early experiments it was thought necessary to fill the retort as full as possible and to leave a plug of "green" coke at the end of the retort to which the steam was supplied. It has been found, however, that no thermal advantage is obtained by so arranging the charge. After trials of several methods of charging, in each of which the aim was to leave a plug at a particular position in the retort, it was found that no improvement in thermal yield was secured over that when the retort was charged in the normal manner. That the method of charging does not affect the yields is contrary to our expectations, and, we should imagine, to those of many of our readers.

Experiments have been carried out on a combination of steaming and increased flow of heating gases. It is shown that this combination led to an increased output of gas per retort of 18·4 therms, or 12%, and an increased

gas yield of rather over 14 therms per ton of coal. The fuel consumption was increased to 5 cwt. These experiments were made at a 10-ton per day throughput, but with an increase in the volume of heating gases to 46,000 c.ft. per hour.

Encouraging Results

THE experiments described in the Report were carried out during a period of ten months. The results obtained, it is stated, "show that the process of steaming in horizontal retorts enables increased thermal yields of gas to be obtained without the necessity of employing complicated or expensive apparatus or skilled staff. No unusual difficulties have resulted, and no greater trouble than usual has been experienced with stopped pipes, when steaming at normal throughputs." The best results at each of three throughputs are summarized in a table on a later page. The most noticeable feature is the increase in the thermal yield per retort per day. At 10 tons throughput the yield obtained was 94 therms per retort, and this was increased to 148 therms when the throughput was increased to 14·5 tons with steam supplied for one hour, the amount being 43·3 lbs. per ton of coal as charged. The Report emphasizes that in considering the results it must be borne in mind that the setting at the Fuel Research Station is an isolated one, and in consequence the loss of heat by radiation and the fuel used in heating the retorts are greater than those of a commercial plant.

It is pointed out in the Report that, until we know more exactly what takes place during steaming in horizontal retorts it is not easy to determine the conditions necessary to produce the result required in any given case. The increased yield of gas is due to at least three causes: The decomposition of the steam by the charge; interaction between the steam and the hydrocarbon gases from the coal; and more complete carbonization at the charge end of the retort due to the sensible heat of the increased volume of gas produced. Attempts are now being made to obtain further information on these points, particularly as regards the amount of steam actually decomposed. The problems which still require investigation are the probable increase in the fuel consumption associated with the method; the determination of the increase in the amount of liquor produced; a study of the modification in the volatile gaseous therms present in the coke obtained, together with the effect of the process on the properties of the coke; and the reactions occurring during the steaming, with particular reference to the effect of the process upon the methane evolved from the coal.

The outcome of these investigations will be of the greatest interest to the Gas Industry. In the meantime there is plenty to study in the results published in the Report under review; and we have no doubt that the Report, which is obtainable from H.M. Stationery Office (price 3s.), will receive the attention of the Industry which its contents so richly merit. The new technique of steaming and re-circulation of heating gases may well have far-reaching effects on methods of gas and coke manufacture.

Smokeless Solid Fuel

IN the foregoing we have referred to only one phase of the work described in the Report, which covers such a wide field. Hydrogenation of coal and tars and the production of smokeless fuels for the open firegrate are treated at length. In regard to the former subject, the present position was discussed by Dr. Sinnatt at a meeting of the Midland Association of Gas Engineers and Managers, and his paper was published in the "JOURNAL" for Nov. 7 last. As to the latter question, experiments on the carbonization of blends of coal, or coals and diluents, in vertical chamber ovens have shown that, by carefully choosing the blends, "free-burning domestic coke can be prepared which combines high bulk density and considerable resistance to abrasion and shatter with reasonably high combustibility and ease of ignition." The cokes contain about 5% of volatile matter, the blends being carbonized with a temperature of 850° C. in the bottom heating flues, decreasing to 650° C. in the top flues. The "Miscellaneous" section includes a note on the deterioration of coal on storage, and refers to the experiments which are being carried out by Mr. J. Jamieson, of Edinburgh.

The Gum Problem

ON other pages will be found the latest contribution of Mr. W. H. Fulweiler, of the United Gas Improvement Company, Philadelphia, to the problem of the formation of gum in gas—and its solution. Appreciating the difficulties and obscurities of this problem, which more than ever is exercising the minds of gas engineers in this country, we have been at pains to keep our readers up to date with investigations in other countries, and have followed closely the work of Fulweiler and his associates. We feel sure that the present contribution, which took the form of a paper before the Technical Section of the American Gas Association at their recent Annual Convention, will be welcomed by our readers and will be of assistance in solving a pressing problem.

It is pointed out by Mr. Fulweiler that one of the more important recent developments has been the discovery that where gas which had contained nitric oxide and had formed particles was freed from nitric oxide and was then carefully filtered to remove the visible particles, the gas still contained particles too small to be visible in the ultra microscope. If this gas is stored these small particles will coalesce and increase in size to a point where they will again extinguish a pilot. Hence, to be useful, filters must be attached to the individual appliances so that no appreciable time elapses between the filtration of the gas and its consumption in the appliance. A filter for this purpose has been designed and constructed during the past year. It has a capacity up to 5 c.ft. an hour and is available for any type of service within this capacity. It is specially adapted for water heater pilots, house heater pilots, and full flow of gas for refrigerators. The author explains that a refrigerator equipped with this filter is operating normally after 187 days on a gas which causes stoppage of ordinary equipment in 6 days for pilots and 40 days for thermostats. In his opinion the use of these individual filters, installed adjacent to the point of consumption, is probably the most immediate answer to the gum problem for plants not in a position to operate the necessary remedial processes for the removal of nitric oxide.

The opinion is also expressed that it will be impossible for appliances in the distribution system to be free from gum stoppages unless the nitric oxide is completely removed from the gas at the works. The author states that in most plants where adequate purification capacity is provided the additional cost of operating oxide purifiers for the removal of nitric oxide is confined to the necessity of closer supervision, and from one to two extra changes of oxide per year, together with proper treatment of the spent oxide. "We estimate," he says, "that the average cost of operating our process should not exceed 0·15 c. per 1,000 c.ft. above the usual purification costs,

and that this increased production cost will be offset many times by the saving in complaint expense and the giving of better service to the consumer." If we translate the 0·15 c. to 0·075d. per 1,000 c.ft., we find, however, that this would add half as much again to the purification costs of many undertakings in this country.

Shareholder Co-operation

In a letter published in the "JOURNAL" last week a correspondent put in a plea for greater co-operation between gas undertakings and their shareholders. His point is that if stockholders *qua* stockholders were kept fully informed by the companies of the advances in the applications of gas and of how to employ gas to the best advantage their enthusiasm in a great Industry would be far keener and would inevitably result in increased sales. From our correspondent's experience there must be thousands of shareholders unaware of many of the uses to which gas can be put—for example, refrigeration and garage and greenhouse heating.

The idea of circularizing shareholders is a good one, and we agree that the money expended on well-written and attractive booklets would be well spent. Which brings to mind the "year book" so excellently exploited by certain companies. An instance is the Newcastle and Gateshead Gas Company, who issue a most attractive Year Book, the first part of which is occupied by the report of the Directors and an account of the proceedings at the annual general meeting of the Company. There follows propaganda material of a very high standard. The Year Book is so well produced that anyone who receives a copy must open it, and anyone who opens it must read it.

Another fine example which immediately occurs to one is the Annual Report and Year Book of the Consolidated Gas, Electric Light, and Power Company of Baltimore. The publication draws attention in an interesting manner and with the aid of excellent illustrations to facts concerning the scope and activities of the Company which ordinarily are a closed book to the general public.

We hope that companies who have not yet tried a Year Book or some other form of circularizing shareholders will consider the suggestion of our correspondent.

Propaganda and Propaganda

We have on occasion referred to antagonistic propaganda set on foot by competitors—propaganda which shows anxiety concerning the progress which the Gas Industry is making. There is an overdose of such electrical propaganda in a recent Housing Supplement to the *Daily Telegraph*, Sir William Ray's sweeping statement in an article in that publication that all-electric homes are "more economical, as well as labour-saving and fumeless," is hardly accurate (a not unusual feature of electrical publicity). The vast body of readers of a newspaper of such high standing, however, who may set store by facts, will realize that such a statement is a trifle "inspired."

More important, though, is Sir William's cry for the abolition of flues, which, he affirms, cost the builder from £8 to £10 apiece, and, in addition, occupy floor space which, if saved, can mean extra rooms in a tall building. Advocacy of the flueless house is definitely anti-social, and can in the long run only bring odium on its sponsors. Sir William shelves the health aspect of flueless rooms. Housewives, we learn, are clamouring for the all-electric house. "Why, then," he asks, "does the new home tarry?" One of his reasons is that the bad, bad builder *will* include flues in modern buildings. The builder, he suggests, is playing for safety. Sir William is right. The builder is playing to safeguard health. And as for economy, Sir William quotes a number of instances to show, of course, that the all-electric house is cheaper than various other types of house combining several fuels; and without any substance in fact airily asserts that "so far as one can judge the all-gas house is more expensive." One might judge so; but two would not.

The good salesman does not decry his competitors' products in such wise; and we found it refreshing to turn to an article in the same Supplement by Sir Francis Goodenough. Here are no unbalanced comparisons. Instead is a straightforward and convincing statement of the work of the Gas Industry in providing labour-saving domestic equipment that combines economy with a better standard of home comfort. Sir Francis points to developments taking place in London in the erection of modern tenement buildings and working-class flats, where gas provides *all* the housewife's essential services. He shows what gas is already doing in the modern home, and does not paint in vivid colours an imaginary Utopia.

Industrialists and Research

It may be said that "Research" was the watchword of the recent annual gathering of the Institute of Fuel, and particularly was it in evidence during the dinner at the Connaught Rooms which followed the business meeting. This dinner was a brilliant function, attended by the Duke of Kent and some 750 members and guests. Though young, the Institute is already fully grown, and in the eight years of its short life it has shown ample appreciation of its important functions. This year's President is Sir Harry McGowan, and the Vice-President Sir Philip Dawson, M.P.; while Past-Presidents include Sir David Milne-Watson and Sir William Larke. Without exception these are men who are enthusiasts in the cause of research. Glancing along the top table at the dinner, many more prominent research workers were noted.

It would be hard to place a limit upon the sphere of usefulness of such a body as the Institute of Fuel, in which already no fewer than 29 countries are represented. The President, remarking that the Institute is founded on research, and that industrialists are becoming more and more research-minded, appealed for increased membership for so useful an organization, and one cannot think that this appeal will remain without response. Who, one wonders, will be the next Melchett Medallist? The Duke of Kent, in making last week's presentation to Dr. Friedrich Bergius, explained that the first recipient was a German industrialist, the second a Swedish scientist, the third an American industrialist, the fourth an English professor, and now they were bestowing the honour upon a German scientist, whose research work on the hydrogenation of coal has laid the foundations of a new fuel industry. The President pointed to the practical application of research of this character by reference to the huge plant which Imperial Chemical Industries are at present erecting at Billingham for the production of petrol from coal and creosote.

In his acknowledgment, Dr. Bergius mentioned, among other workers "who really deserved the medal as much as himself," Dr. Ormandy, Prof. Lander, and Dr. Dunstan. To them also we may apply the remark of Mr. Oliver Stanley, Minister of Labour, when replying for the visitors, that to people like Dr. Bergius we owe nothing but gratitude.

Meditation

At any rate two of the important railway termini in London are now provided with "news theatres," in which persons who are awaiting the departure of trains are able to spend the time comfortably watching the reeling off of a film. One may, through circumstances beyond control, just miss a train home at a time when such a misfortune involves a wait of an hour or more, and this during the hours in which grandmotherly legislation prohibits the serving of alcoholic refreshment, whatever may be the bodily needs. How often at the end of a hard day, perhaps thoroughly worn out by travelling, has one in these circumstances stood shuddering on a draughty railway station platform, thinking all sorts of kind things about matters in general and parliamentary representatives in particular! To-day, in the case of the two London termini referred to, things are altered, and during a great part of the twenty-four hours there is presented, as an alternative, the possibility of sitting at ease in an atmosphere of cheerfulness and warmth.

In meditating thus, we have not forgotten the railway station waiting room, but this as a place of refuge is by no means universally esteemed. Accommodation of that character in some of the most important places is doubtless adequate, but in the case of the great majority of stations the cheerless, box-like waiting room of long ago is still with us. It is indeed the persistence of these old-time structures that is responsible for the penning of these peregrinating lines; for in such waiting rooms there is (sometimes) a waiting-room fire, and Mr. W. R. Gordon, Director of the Coal Utilization Council, has been "poking fun" at these waiting-room fires. The occasion was opportune, as he was addressing a Railway Lecture and Debating Society, and perhaps, as the result of what he said, something may in time be added to the pleasures of railway travelling and subtracted from its pains. It is Mr. Gordon's opinion that the railway waiting-room fire "too often ranks with the railway sandwich as a somewhat dreary joke," and he is out to see this changed, not, seemingly, primarily impelled by pity for the stranded passenger, but because he believes that, "with a little thought, skill, and attention, waiting-room fires can be made into timely and practical advertisements of the comfort of a coal fire—advertisements that will be much appreciated by members of the travelling public at this season of the year."

And if coal, why not gas? If there is need for timely and practical advertisements of the comfort of a coal fire, our Industry should not be behind in demonstrating wherever possible the artistic merits, the cleanliness, and the efficient operation of gas fires. Leaving waiting rooms for the moment, but pursuing the text, we have from time to time, when journeying about, met with gas fires in more or less public positions which answered to the description of a "somewhat dreary joke." Exactly how Mr. Gordon proposes to make the waiting-room coal fire so convincing, we do not know, but the way to advertise all the advantages of gas fires is by adequate maintenance both when in use and when out of use. "Groggy" looking gas fire radiants—radiants the unintended positions of which are suggestive of "we won't go home till morning"—is a bad advertisement, and not until every radiant in every fire in every place where it can be seen is in correct position, and is left in correct position, summer and winter, will the Gas Industry be able to say that there is nothing more to be done. Do not let us for one moment delude ourselves with the thought that it is only the railway waiting-room coal fire that is capable of improvement.

Correspondence

Undesirable Films

Sir,—With reference to your Editorial comment regarding undesirable films ("Journal" for Nov. 14, p. 510), we have had the unfortunate experience of losing a good consumer, because he has taken the viewpoint that there is a danger of servants turning on the gas and committing suicide.

This gentleman is a solicitor by profession, and feels that it is his bounden duty to protect his staff from any means of self-destruction.

However, I drew his attention to the fact that the installation of water would not preclude his servants from drowning, or the provision of sharp knives from cutting their throats.

There is no doubt whatever that the effect of these undesirable films is definitely going to be detrimental to the Gas Industry.

Yours, &c.,
Alec. E. Whitcher,
General Manager.

Haywards Heath District Gas Company,
Haywards Heath,
Nov. 22, 1934.

Concentrated Liquor

Sir,—With reference to your report of the discussion on the 4th Report of Liquor Effluents and Ammonia Sub-Committee ("Journal" for Nov. 14, p. 520), we notice some remarks passed by Mr. P. Parrish on the subject of concentrated liquor which we think may cause some misunderstanding.

We are aware that concentrated gas liquor of a specific gravity greater than unity is transported by rail at Class 3 rate, but we disagree that crude concentrated gas liquor of 22% strength comes under any different classification, bearing in mind that it contains all the impurities commonly present in the weaker grade, but in slightly different proportions.

The specific gravity of crude concentrated gas liquor of 21 to 22% strength tests over unity, as has been demonstrated on working tests on our plant; in one plant the specific gravity being steadily 1·105. In our opinion, therefore, the 22% concentrated gas liquor can be transported under the same classification as the 15 to 18%.

Class 6 specification refers to semi-pure aqueous solutions concentrated to a point where it contains 25% NH_3 with less than 0·5% H_2S. The volatility of this product is well known, and its specific gravity is below unity.

Mr. Parrish also states that the cost of production of concentrated gas liquor is 5d. to 6d. per unit, and that in some instances it can be disposed of at a figure of 1s. 3d. per unit.

Would it be possible to have some enlightenment on this point, as we know several recent cases where a figure as low as 4d. per unit has been offered, even by fertilizer manufacturers, which on his own showing represents a loss?

We feel that the matter requires some further investigation owing to the origin of the statements in question, and their importance to gas engineers.

Yours, &c.,
L. O. Wilton.

The Chemical Engineering and
Wilton's Patent Furnace Company, Ltd.,
76, Victoria Street, London, S.W. 1,
Nov. 22, 1934.

Personal

THE CAMBRIDGE APPOINTMENT.

In succession to the late Mr. J. W. Auchterlonie, the Directors of the Cambridge University and Town Gas Light Company have appointed Mr. HAROLD SHEWRING to the position of Engineer and Manager. Mr. Shewring comes from Rochdale, where he has been Engineer and Manager of the Corporation Gas Department.

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PRESENTATION TO RETIRING M.F.H.

An interesting link between the Gas Industry and sport is illustrated in the accompanying photograph, the occasion of which was a presentation, at the opening Meet on Nov. 5, to Lieut.-Colonel and Mrs. H. W. Woodall by Sir John Lees on behalf of members of the South Dorset Hunt, and

farmers and friends in the South Dorset country, on their leaving there after 30 years' residence. Colonel Woodall was for many years Hon. Secretary of the Hunt, and subsequently Joint Master. We believe that Colonel Woodall is the only gas engineer who has been a Master of Fox Hounds.

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Sir FRANCIS and Lady GOODENOUGH had the honour of being invited to Their Majesties' Evening Party at Buckingham Palace on Tuesday, Nov. 27, in connection with the festivities attending the marriage of H.R.H. the Duke of Kent to the Princess Marina.

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The Oldham Finance Committee have appointed Mr. C. WORSWICK Public Lighting Superintendent in succession to the late Mr. I. H. Massey. About twenty years ago Mr. Worswick joined the Distribution Staff of the Corporation Gas Department, and in 1924 he received a staff appointment in the then newly formed Lighting Department.

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After many years' service, Mr. F. HILL, Engineer and Manager of the Usk Gas Company, has just retired. Some years ago in recognition of his long and faithful service the Directors of the Company presented him with a gold watch. He is one of the few remaining original members of the Wales and Monmouthshire Association of Gas Engineers and Managers. Mr. Hill was a keen cricketer and continued to participate in the game when many would have been content to play the rôle of spectator. We understand that his successor is Mr. JOHN KING, of the Pontypool Gas and Water Company, who takes over his new duties on Dec. 1.

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The Cheshire County Council have agreed to the appointment of Mr. J. H. NOBLE, Engineer of the Chester United Gas Company, as Gas Examiner for the area supplied by the Ellesmere Port Gas Undertaking.

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After 54 years in the Gas Industry, Mr. F. FAWCETT, Engineer, Manager, and Secretary of the Egremont Gas Department, retires at the end of the present year, having served this Undertaking for the last 34 years. He had previously been with the Leeds, Retford, and Cleator Moor Undertakings, and now, at the age of 67, he looks back upon many changes in the manufacture and distribution of gas and has seen service in both large and small works.

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A presentation was recently made to Mr. DAVID MOFFAT, Superintendent of Gas Mains, Edinburgh Gas Department, on the completion of 51½ years' service.

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Mr. JAMES MELLOR, Assistant Manager of the Rochdale Corporation Gas-Works, retired from the position on Saturday, Nov. 24, after 55 years' service in the Department. He had seen service under four Managers: Mr. T. O. Patterson, who later went to Birkenhead, where he was Manager for many years; Mr. William Romans, who went to Rochdale from Sheffield; Mr. Ball, who was Manager for over 40 years; and Mr. Shewring.

Obituary

The death took place on Nov. 24 of Mr. G. H. BRADDOCK in a Manchester nursing home. He was Chairman of Meters, Ltd., Manchester, for over twenty years.

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The death is reported of Mr. I. H. MASSEY, who has been for some years the Public Lighting Superintendent at Oldham.

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A Director of the Seaton Gas and Coke Company for over 30 years, from which position he retired only recently, Dr. GEORGE EDWARD ALFRED EVANS recently passed away at his home at Chard at the age of 71.

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Mr. JOHN TAYLOR, former Manager of Coleraine Gas-Works, passed away suddenly on Nov. 20 at his residence at Portrush. He served his apprenticeship at the Coleraine Gas-Works, whither he returned as Manager in 1903, succeeding Mr. S. F. Langlands, now with the Glasgow Corporation Gas Department. Mr. Taylor retired in 1927, being succeeded by his nephew, Mr. F. G. M'Ilwee, the present Manager.

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On Nov. 20—the eve of the inauguration ceremony of a new holder erected at Southampton, an event reported elsewhere in this issue—the death took place suddenly of Mr. EDWIN DUNBAR, Assistant Engineer to the Southampton Gaslight and Coke Company. Mr. Dunbar, who was 55 years of age, had served the Company for exactly 39 years, having joined as a junior in the works in November, 1895. His loss will be deeply felt among all ranks at the works, where he was very popular and much esteemed. He was closely associated with the Employees' Sick Benefit and other Funds.

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Mr. JAMES MILLER, who has been Engineer and Manager of the St. Neots Gas and Coke Company (Huntingdonshire) for 24 years, died in Addenbrooke's Hospital, Cambridge, on Nov. 21 at the age of 64. Before going to St. Neots, he held appointments in Gas-Works in Scotland, Brazil, and Dolgelly.

Forthcoming Engagements

November

29.—I.G.E.—Meeting of Meters Committee, 2.30 p.m.
30.—SOUTHERN ASSOCIATION.—General Meeting, Hotel Metropole, London, 2.30 p.m.

December.

1.—WESTERN JUNIOR ASSOCIATION.—Meeting at Taunton. Paper by Mr. D. H. Sullivan.
3.—GAS COMPANIES' PROTECTION ASSOCIATION.—Meeting of the Committee at 5, Victoria Street, S.W. 1, 2.30 p.m.
5.—MANCHESTER AND DISTRICT JUNIOR ASSOCIATION.—Visit to Messrs. Donald Macpherson & Co., Ltd., Knott End. Paper by Mr. W. A. Lowe.
6.—MIDLAND JUNIOR ASSOCIATION.—Meeting and Paper by Mr. S. Brockbank (Walsall).
8.—SCOTTISH JUNIOR ASSOCIATION (WESTERN DISTRICT).—Meeting. Paper by Mr. J. Bateman.
13.—NATIONAL GAS COUNCIL.—Meeting of the Central Executive Board, at 28, Grosvenor Gardens, S.W. 1, 2.30 p.m.
13.—S.B.G.I.—Council Meeting, 2.30 p.m.
14.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting and Paper by Mr. G. P. Manning.
15.—WALES AND MONMOUTHSHIRE JUNIOR ASSOCIATION. Meeting at Cardiff. Paper by Mr. G. S. Leonard.
15.—YORKSHIRE JUNIOR ASSOCIATION.—Meeting in Sheffield. Presidential Address of Mr. R. Halkett, Jun.

News In Brief

The Institute of Linguists held their Autumn Annual Conference at Portland Hall, Great Portland Street, W., last Saturday. The President this year is Sir Francis Goodenough, C.B.E.

A Reduction in the Price of Gas is announced by the Brechin Gas Company of 1d. per 1,000 c.ft., making the new rate 4s. per 1,000 c.ft. This is understood to be the fifth price reduction in six years.

Cookery Demonstrations were a feature of the exhibition held under the auspices of the Catrine Gas Company, Ltd., and the Parkinson Stove Company, Ltd., which was opened in the Wilson Hall, Catrine, on Nov. 19.

Price Reductions announced this week include the following: Burton-on-Trent (outer area) to 1s. 1d. per therm; Friockheim by 1d. per 1,000 c.ft.; and Musselburgh by 4½d., making the price 3s. per 1,000 c.ft.

Over 200 Members attended the Second Annual Dinner of the Southampton Gas Company's Athletic and Social Club at Edwin Jones' Restaurant on Nov. 15, when Sir Russell Bencraft (Chairman of the Company) presided.

A Four-Lift Gasholder is to be erected by the Johnstone Town Council on the site of the present No. 1 holder. The new holder will have a capacity of 440,000 c.ft. The contract has been placed with Messrs. R. & J. Dempster, Ltd., of Manchester.

A Resolution, proposed by the Ballymena Urban Council, to transfer £1,000 from the Gas Department to the Rating Department to meet the cost of the additional education rate, and so obviate the necessity of borrowing, was defeated by a large majority.

Copies of the Recently Published British Standard Specification for Plug and Socket Gas Connectors for Portable Appliances (No. 570-1934) may be obtained, price 2s. each, from the Secretary, Institution of Gas Engineers, 28, Grosvenor Gardens, London, S.W. 1.

A Substantial Increase in the value of imports of cast gas pipes and fittings is reported from the Irish Free State —a total for the month of £14,663; and £169,984 for the nine months represents a substantial increase on the figure of £109,352 for the corresponding nine months of 1933.

That Wigton Was One of the First Ten Towns in the United Kingdom to adopt gas for lighting purposes was an interesting statement made at a meeting of the Wigton Toc H by Mr. A. L. Robertshaw, Engineer and Manager of the Wigton Gas-Works, when he gave a talk to the members at their Annual Meeting.

The Travelling Showroom of Messrs. R. & A. Main, Ltd., visited Fraserburgh at the completion of a tour commencing in March. Despite the bad weather, the Fraserburgh Gas Department did a large amount of business in cookers and fires, and the cooking sessions given by Miss K. Whittaker were enthusiastically attended.

The Dunlop Gas Light Company, with offices at Carmelbank, Dunlop, Ayrshire, is a new private Company with a capital of £15,000, which has just been registered in Edinburgh. Its purpose is to acquire the undertaking and business formerly carried on by the Dunlop Gas Light Company in Dunlop and the adjoining district.

A Fifteen Years' Contract for the street lighting of Radyr—a residential neighbourhood adjoining Cardiff and Llandaff—has been entrusted to the Cardiff Gas Light and Coke Company, to be put into operation on Jan. 1 next. As it is a rural district, fluted pre-cast ferro-concrete columns are to be employed to suit the environment.

The New Showrooms of the Gas Department of the Penrith Urban Council were opened on Saturday, Nov. 24, and have attracted much local attention. The premises are large and roomy and have been most effectively adapted to their present use. The Engineer and Manager, Mr. J. Corrigan, reported that a series of lectures has been arranged in the neighbourhood by the British Commercial Gas Association.

"Gas Meters" formed the subject of a very interesting lecture recently delivered by Mr. A. T. Gilbert, Technical Demonstrator, United Gas Industries, Ltd., to the Fitting and Collecting Staff of the Sherborne (Dorset) Gas Company. Throughout the lecture the points were illustrated by working and other models. Great interest was shown throughout, and a useful discussion followed. At the conclusion of the lecture, Mr. W. H. Wise, in thanking Mr. Gilbert, paid tribute to the pains taken to make the points clear, and also to the need of such education for District Staff.

A Motor Barge was inspected by members of the Leicester Gas Committee on Wednesday, Nov. 21. The barge which is driven by oil produced at the local Gas-Works is christened "Robinson" after the late Mr. C. S. Robinson who was Joint Engineer with his brother of the Leicester Gas Undertaking before it was taken over by the Corporation 56 years ago.

Increased Output at Falkirk.—Mr. H. G. Ritchie, Engineer and Manager of the Falkirk Corporation Gas Department, reports that the output for October was 37,903,000 c.ft., being an increase over October, 1933, of 1,316,000 c.ft. From May 15 to the end of October the output was 173,702,000 c.ft., an increase over the corresponding period of last year of 10,438,000 c.ft., or 6·39%.

Tenders are Invited by the South Suburban Gas Company for a new issue of £200,000 of 4½% perpetual preference stock at a minimum price of issue of £105 per £100 of stock. This stock will rank after the debenture stocks and *pari passu* with the existing preference stocks, and yields at the minimum price £3 16s. 2d.%. Tenders must be delivered by 12 noon on Monday, Dec. 10, next, in amounts of £10 or multiples thereof.

Mr. Charles F. Botley, M.Inst.C.E., Engineer and General Manager of the Hastings and St. Leonards Gas Company, presided as Chairman of the Municipal Science and Arts Schools on the occasion of the Annual Prize Distribution by the Mayoress, Mrs. Lancelot Blackman, which recently took place at the Town Hall, Hastings. Dr. Margaret Fishenden, of the Imperial College of Science and Technology, delivered an interesting address on "The Scientific Attitude."

The Annual Dinner of the Rugby Gas Company Social and Sports Club was held at the Peacock Hotel, Rugby, being attended by some sixty members of the staff. Mr. R. Meiklejohn (Engineer, Manager, and Secretary of the Company and President of the Club) was in the chair, and was presented by Mr. J. R. Phelps (Chairman of the Committee) with a chiming clock on the occasion of his recent marriage. The evening was devoted to an entertainment provided by members of the Club.

Application is to be Made by the City of Birmingham for a Special Order under the Gas Undertakings Acts, 1920 and 1929, to extend the limits within which the Corporation are authorized to supply gas by the addition thereto of certain parishes, or parts of parishes, in the counties of Stafford, Warwick, and Worcester, and in the rural districts of Lichfield, Meriden, Stratford-on-Avon, and Tamworth. The Order also seeks to transfer and vest in the Corporation the Undertaking of the Coleshill Gas Company, Ltd.

Gas-Driven Vehicles for South Wales.—As one of the four Government Commissioners who have been investigating conditions in Britain's depressed areas, Sir Wyndham Portal, the Commissioner for South Wales, in the course of his recently-issued Report states that a substantial increase in the present output of the Welsh coalfield cannot be expected and that the only prospect of increasing production is by finding new uses for coal along scientific lines. In this connection he asked the Government to consider the encouragement of the use of gas-driven road vehicles.

Simultaneously with the Opening of their fine new showroom premises at Redditch (described and illustrated on another page of this issue) the Directors of the Redditch Gas Company have announced a reduction in the scale of charges for gas—a block scale which has been in operation during the past two-and-a-half years, which has proved successful in promoting increased sales particularly to domestic consumers. This now provides for the substantial reduction of 2d. per therm upon the consumption in excess of the first 5,000 c.ft. per quarter. Formerly a reduction of 1·2d. per therm was given after the first 7,500 c.ft.

The Record Output of 13 million c.ft. during October has prompted Mr. H. A. Aitken, Engineer and Manager of the Buckhaven and Leven Gas Board, to emphasize his recommendation that they should extend the vertical retort plant by adding four retorts for which they have ample room. The estimated cost is about £6,700. He suggested that the work be proceeded with so that they could cope with the steadily increasing demand. He outlined the progress of the undertaking, and stated that centralization had been carried through ten years ago. The capital debt had been reduced to £80,000, which was £4,000 less than last year.

The "Westvertical" System of Carbonization.

Recent Contracts.

Three very interesting contracts have been booked by Messrs. West's Gas Improvement Company, Ltd., Manchester, for installations on their new "Westvertical" system of carbonization. An abstract of the patent specification No. 395,092, describing this system, was given in our issue of Oct. 8, 1933, p. 221.

In this country the Watford and St. Albans Gas Company has placed a contract for an installation of a daily capacity of just over 3 million c.ft. when carbonizing Durham coals, and complete with coal and coke handling and waste-heat recovery plant; and the Willenhall Gas Company for an installation of 600,000 c.ft. daily capacity.

The North Shore Gas Company, Sydney, N.S.W., has placed a contract for a complete installation of a daily capacity of 3 million c.ft., with waste-heat boilers and extensive coal-handling plant, linking the new installation up with the existing Glover-West retort house.

British Gas Light Company, Ltd., to Purchase Hull Corporation Gas Undertaking.

We learn that an arrangement has been made for the British Gas Light Company to purchase the Hull Corporation's interest in the Old Town Gas Undertaking as from Jan. 1 next.

The Hull Corporation purchased the Undertaking of the Kingston-upon-Hull Gas Light Company—whose area of supply comprised what is known as "Old Town"—under the terms of an agreement dated April 10, 1897, the sale and transfer being confirmed by the Kingston-upon-Hull Corporation Act, 1897.

Under the provisions of that Act, the Corporation was also empowered to pull down and remove the gas-works of the old Company and to sell and dispose of all plant, &c., subject to satisfactory binding arrangements being made with the British Gas Light Company, Ltd., and the Sutton, Southcoates, and Drypool Gas Company, or either of them, to furnish a supply of gas to or for the district. Accordingly the Corporation entered into an agreement in 1898 with the British Gas Light Company, Ltd., to furnish a supply of gas in bulk, the Corporation taking the supply at a meter on the border of their area and themselves distributing the gas to their consumers.

It may be interesting to record that part of the site of the present Guildhall comprises land on which the old gas-works stood.

North of England Gas Managers' Association (Auxiliary Section).

Half-Yearly Meeting at Newcastle.

The 29th Half-Yearly Meeting of the Auxiliary Section of the North of England Gas Managers' Association was held in the Gas Offices, Newcastle, on Saturday, Nov. 24, Mr. F. P. FALL (Engineering Assistant, Sunderland Gas Company) presiding.

Election of Officers.

The following Officers were elected for the year 1934-35:

Chairman.—S. A. Wikner, F.I.C. (Newcastle).

Vice-Chairman.—J. R. Porter (South Shields).

Hon. Secretary.—L. M. Weldon (Hartlepool).

Mr. D. Yule (South Shields) was elected to the Committee.

The following Officers were re-elected: Hon. Secretary, Mr. L. M. Weldon, of the Hartlepool Gas and Water Company. Members of Committee: Messrs. J. W. Pallister, Middlesbrough; G. Neil, West Hartlepool; G. J. Duncan, North Shields; F. Nicholls, Gateshead; T. T. Tarn, Darlington.

Mr. FALL, proposing Mr. Wikner as Chairman-elect as the nomination of the Committee, said they could not have a better man to conduct their affairs.

Both he and Mr. Porter were elected to their respective offices unanimously.

Expressing thanks, Mr. WIKNER said he would do his best to follow the example and tradition of his predecessors.

Mr. Wikner was formerly Manager of the Hull tar works of Messrs. Major & Co., Ltd., and later became Manager of the Birmingham tar works of Messrs. Hardman, Ltd. He was appointed to his present position at Newcastle in 1919.

Mr. W. O. Kirkwood (Chief Chemist of the Sunderland Gas Company) then presented his paper on "Conservation of Heat Energy in Relation to Horizontal Retort Practice," which will be found on other pages of this issue.

Vote of Thanks.

Mr. WIKNER proposed a vote of thanks to Mr. Kirkwood, which was seconded by Mr. F. NICHOLLS and warmly expressed by members.

Mr. Wikner then presented the retiring Chairman with a Presidential Certificate to mark his year of office.

Mr. C. S. READ moved a vote of thanks to the Chairman and Officers, seconded by Mr. J. RICHARDSON, Sunderland.

Mr. Weldon was specially thanked for his work as Hon. Secretary, and the meeting concluded with tea taken in the Gas Offices.

A Happy Group.

The above photograph was taken on the occasion of the opening of an "Evening Express" all-gas house in Liverpool on Nov. 22, and shows Mr. J. Sandon Stubbs, Secretary of the Liverpool Gas Company, presenting the Lady Mayoress with a bouquet. Readers will readily recognize Mrs. Eileen Murphy, Director of the B.C.G.A. Home Service Section, as another member of the group.

Model All-Gas House on New Estate.

South Suburban Company's Enterprise.

For some little while past the South Suburban Gas Company have had a completely equipped all-gas house for demonstration purposes on the Station Meadow Housing Estate which is being put up at Dunton Green—a rapidly expanding village a few miles north of Sevenoaks and one which may in the not too distant future become another of London's "dormitories" now that the Southern Railway are extending their suburban electrification system as far as the latter town.

The new Estate adjoins the main Hastings road and consists of small semi-detached three-bedroom houses selling, on the instalment plan, at about £500 freehold. A large hoarding announcing particulars of the Estate is illuminated at night by four high-power gas lamps, while one of the show houses is floodlighted by two seven-mantle gas flood-lamps.

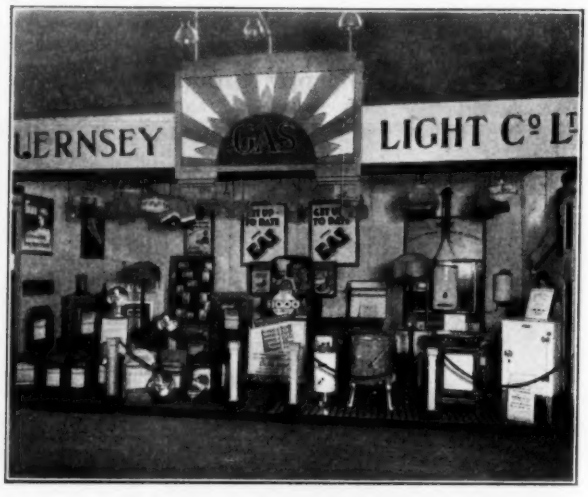
The all-gas show house was equipped with a gas fire in the sitting-room, while a gas poker served to ignite the dining-room fire which supplied the main hot water supply by means of a back-boiler. In the kitchen was an all-enamelled cooker, a wash-copper, and a Ewart's "Allhot" sink water heater with rectangular body finished in white porcelain enamel. A Davis gas iron was also an addition to the kitchen fittings.

Upstairs, two of the bedrooms were supplied with modern gas fires in coloured finishes, while the third had as its

heating medium a " Ravex " portable heater by Messrs. Falk, Stadelmann, & Co., Ltd. For bath water purposes, when the back-boiler was not in operation, there was a Righton's " New Rapid " geyser in copper finish.

Attractive gas lighting fittings completed the equipment of this model house, which served as an effective counter to the all-electric dwelling also exemplified on this Estate. The South Suburban Company are to be congratulated upon their enterprise in showing all that gas can do in this type of home.

Publicity in the Channel Islands.



The above display was arranged by the Guernsey Gas Light Company, in conjunction with the Davis Gas Stove Company, Ltd., at a recent Trades and Industries Exhibition. Mr. R. G. Luxon, the Engineer and Manager of the Guernsey Company, tells us that some £600 worth of gas apparatus was sold during the eight days of the Exhibition, and this despite the fact that there are up-to-date showrooms in Guernsey—a striking proof of the value of trade displays of this nature.

The British Road Tar Association.

Luncheon Meeting at Cardiff.

On Thursday, Nov. 22, the British Road Tar Association assembled at the Park Hotel, Cardiff, for their Luncheon Meeting which was attended by over two hundred members and guests.

The toast " Our Guests " was ably proposed by Mr. H. D. Madden, Engineer and Manager of the Cardiff Gas Light and Coke Company, who was in the Chair. Mr. R. G. Clarry, M.P., Chairman of the British Road Tar Association, responded to the toast of " The British Road Tar Association."

The Engineering Exhibition.

After the Luncheon, which was acclaimed as an unqualified success by all, the party left for the Greyfriars Hall where the Engineering Exhibition, held under the auspices of the South Wales Institute of Engineers, was opened the previous day. The members of the Wales and Monmouthshire Association of Gas Engineers and Managers were officially received at the Exhibition by Mr. J. Macleod Carey, O.B.E., President of the South Wales Institute of Engineers. Mr. H. Barker (Llanelly), President of the Association, replying to Mr. Macleod Carey's words of welcome, said they very much appreciated the opportunity of making an official visit to the Exhibition which more than maintained the high standard set by those of other years.

An inspection of the exhibits followed the official reception. The British Road Tar Association's stand was every bit worthy of the work that they are carrying out in encouraging and developing the use of coal tar and coal tar products for road and other purposes. A specimen road laid with tarred chippings attracted considerable attention. Other interesting features of this exhibit were a film lent by the Powell Duffryn Company entitled " Coal Getting," laboratory tests for tars, and lightning sketches of a humorous nature by Miss M. Lynham.

The Cardiff Gas Light and Coke Company and Mr. Madden were rightly congratulated upon the excellent stand they arranged in conjunction with the South Wales Industrial Gas Research Centre. Incidentally, we were interested to note that in addition to embracing the majority of undertakings in that area, this Centre includes as a member, far-away Waterford! Among the exhibits on this stand were radiant and unit heaters, a milk bottle sterilizer capable of dealing with 74 bottles at a time and other small industrial appliances suitable for the various trades and industries of South Wales.

The exhibit of the Department of Scientific and Industrial Research included low-temperature tar, coal-oil suspensions and plastic materials turned therefrom, syntheses under pressure, corrosion of metals, hydrogenation of coal and smokeless fuel. Among other exhibitors were International Combustion, Ltd., London, George Kent, Ltd., Luton, and Stewarts & Lloyds, Ltd., Birmingham.

Kettering Company's Centenary.

Another gas undertaking—and one which may be said to have " made history " in the Industry by reason of its Act of 1932 which established an important principle which has since been embodied in general legislation—celebrates its centenary this year.

It was on Dec. 13, 1833, that twenty-five leading townsmen met to consider a proposal for forming a gas company in Kettering, and it was unanimously resolved that, 60 shares of £25 each having been subscribed for, a Company should be established for supplying the town with gas. In June the following year ground for the proposed works had been purchased for the sum of £100, and the tender of Messrs. Barlow & Sharpe, of London, for the erection of the plant was accepted.

A General Meeting was held on Aug. 13, 1834, when the Trust Deed of the Kettering Gas Light and Coke Company was duly signed by the members present. The original capital of the Company was £2,500, divided into 100 shares of £25 each. On Friday, Oct. 31, 1834, gas was first made, and the first public lighting of the town with gas took place in the evening of that day.

At this period Kettering possessed no railway facilities, and the Company's coal was generally consigned to the canal wharf at Market Harboro', but occasionally it came to Thrapston by rail. Thence it was carted to the Gas-Works from Harboro' at a cost of about 6s. 9d. per ton. This state of affairs existed until the railway was opened for traffic on April 15, 1857.

It appears from the records that, since the commencement, the bulk of the gas requirements of consumers was charged for by meter, and the price was 12s. 6d. per 1,000 c.ft. A reservation being made that a consumer must guarantee that his consumption of gas shall be equal to an amount of not less than 30s. per year. By December, 1852, the price of gas had been reduced, and the following graduated scale of charges was introduced:

To Consumers not Exceeding—

Winter.		Summer.	s.	d.	
500 c.ft.	..	200 c.ft. at 10	0	per 1,000 c.ft.	
3,000 ,,	..	4,000 ,,	8	4	,, ,,
20,000 ,,	..	7,000 ,,	7	6	,, ,,
All above these quantities		,,	6	8	,, ,,

In the year 1865, the number of public lamps had reached 88, and the output amounted to 5,651,000 c.ft.

In the year 1855 a second gasholder of 11,000 c.ft. capacity was erected and additions to retort house and other plant made. A third gasholder of 27,489 c.ft. was installed in 1863, which brought the gas storage up to 46,000 c.ft. None of the above holders is in existence to-day. By way of comparison it is interesting to note that the first gasholder contained only 7,000 c.ft. and constituted the total gas storage capacity, while at the present time the storage is equal to 1,250,000 c.ft. During succeeding years, further land was acquired, and another gasholder of 112,000 c.ft. built, together with other additions, indicative of the expansion of the Company's business.

Statutory Powers.

In the year 1881 the Company was incorporated and registered under the Companies Acts (1861-1880), and in the following year, 1882, statutory powers were granted under the name of the Kettering Gas Company, Ltd., by Provisional Order. At the end of 1887, a fifth gasholder of 100 ft. diameter and 450,000 c.ft. eventual capacity, had been erected and brought into use, and further new plant included additions to retort house, purifiers, &c., and other buildings. The following year, 1888, offices were built at the works, with a frontage to Gas Street.

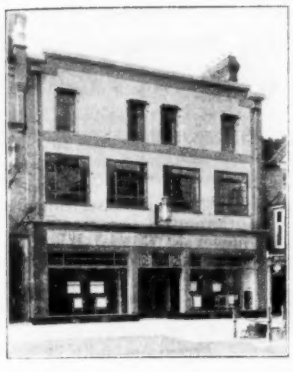
In the spring of 1904 the Company's present offices and showroom in the High Street were opened, and not only

did this step conduce to the convenience of consumers, but it enabled the advantages of the many and varied types of gas appliances to be brought to the notice of the public. The steady increase shown in the number of these articles disposed of and let on hire affords the best evidence that the move was a wise one.

The Company realized as early as 1904 that the free maintenance of burners and other apparatus would be of great benefit all round, and so were among the first gas undertakings to inaugurate a scheme and adopt a system which is still continued and appreciated by consumers. A site on the western portion of the Company's extensive works was selected in 1912, and within eleven months new and up-to-date carbonizing plant was at work. The retort house and coal store form one building, the inside measurements of the former being 108 ft. by 56 ft., and 41 ft. high, and those of the coal store 108 ft. by 40 ft., with a height of 30 ft. The steel hopper holds 170 tons of coal, and this feeds the series of 64 through horizontal retorts. The plant is able to produce more than a million c.ft. of gas per day. Following the strenuous and anxious period covered by the war years, it was found expedient in 1920 to install a carburetted water gas plant, as a precautionary measure and to supplement the existing coal gas process.

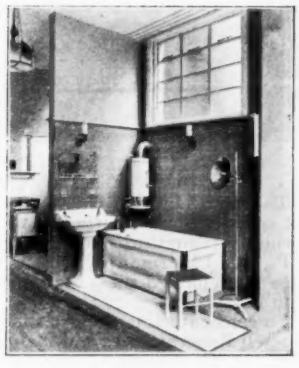
The one hundred years, during which the Kettering Gas Company has been evolving, has been a century of astonishing progress. Readiness to explore new ways and adopt improved methods will continue, and in the years to come it will be the Company's constant aim to maintain a thoroughly efficient gas service.

Fine New Showrooms at Redditch



The Exterior.

Cooking and Water Heating Section.



Model Bathroom.

The new gas showrooms, recently opened by the Redditch Gas Company, are upon a much more ambitious scale than the old premises, and embody features illustrative of the most modern methods in the display of gas appliances.

The front elevation—some 36 ft. wide—comprising a ground floor and two upper floors, is treated on modern lines of dignified simplicity and solidity. The generously proportioned fascia of the shop-front and its sturdy supporting columns are of Braemar granite and the name of the Company is displayed in gilded bronze letters of Roman type upon an inset panel of Cornish Carnsew granite. The lobby floor is of Terrazzo with the Company's monogram inset in mosaic and the ceiling is a laylight lead glazed with tinted cathedral glass having a frontal fanlight similarly glazed in a tasteful design, all of which is artificially illuminated by concealed gas burners. The back of the lobby is a single clear glazed panel through which an unobstructed view of the showroom interior, some 80 ft. in length, is obtained.

Two heavy bronze glazed doors, one on each side of the lobby, give entrance to the Gas Fire Salon—a lofty hall with panelled ceiling and oak floor, where modern gas fires of many types are fitted in tasteful settings; and each one is demonstrable in use, the mere touch of a switch being all that is required of the attendants to show a client his particular choice of a fire actually in operation. The lighting in this section of the showroom is mainly by ceiling ventilating lamps of a pleasing design in consonance with the architectural lines of the interior. Further concealed burners are used above laylights in the two main windows. A most attractive ingle-nook housing a Clipsham stone Tudor fireplace with a most realistic log fire (a gas fire needless to say) is also illuminated upon this sub-laylight principle.

The whole of the ground floor is unobstructed by division walls, and one passes to a model kitchenette, adjacent to which is a model bathroom.

On the same floor is the marble floored and laylighted annexe in which is displayed a comprehensive range of gas cookers of all sizes and types, finished in a variety of coloured vitreous enamels, together with a selection of gas water heaters of all types. The whole of the apparatus in this annexe is lighted upon the same principle as that used for the main windows.

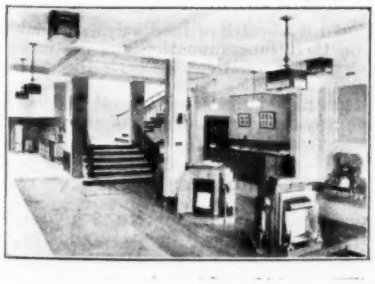
An attractive oak counter serves the Inquiry and Accounts Department, in which modern lighting fittings, radiators, and other appliances are displayed in use.

Above this portion of the showroom is a balcony approached by a fine staircase leading to the first floor. The lofty walls of the staircase are treated as Portland stone and ceiled by a cathedral glazed laylight. The balcony is oak floored and is panelled with waxed oak dado, above which the walls are stippled in stone colour to the cornice of the panelled ceiling. Displays of additional gas-using appliances will be exhibited on the balcony periodically, but the tastefully designed permanent lighting fittings and a gas fire in a Hopton-Wood stone setting are worthy of note.

A very fine Demonstration and Lecture Hall, approached through curtained archways from the balcony, occupies the whole of the remainder of the first floor. This Hall also is panelled in waxed oak as the balcony, and concealed cupboards are fitted with the equipment used in cookery demonstrations which will be given here regularly. The heating on this floor is by radiators fed from a gas-fired central heating boiler and by a panel type gas fire in a handsome golden onyx and Bleu Belge marble setting.

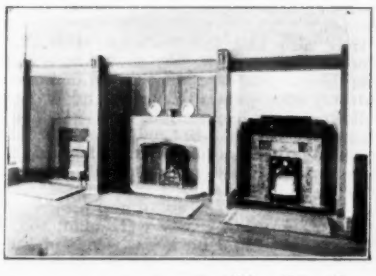
It is interesting to note that all the lighting fittings and gas fires in the building are switch operated.

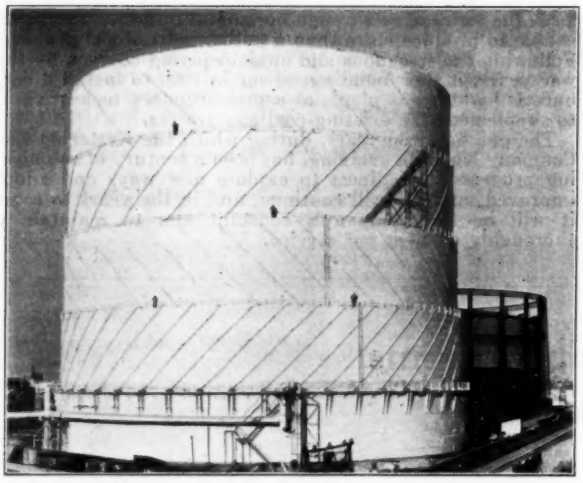
The Company's Distribution Superintendent and Staff were responsible for the installation of the exhibited apparatus and attendant services, and the Architect was Mr. C. F. W. Rendle, the Company's Engineer, who also personally supervised the whole reconstruction.



Left.—A General View of the Main Showroom.

Right.—Some Attractive Gas Fire Settings.





New Spiral Holder Inaugurated at Southampton

Sir Russell Bencraft Sets 3½ Million C.Ft. Structure to Work

The Southampton Gaslight and Coke Company's new 4-lift spirally-guided gasholder of 3½ million c.ft. capacity was formally inaugurated on Nov. 21 by Sir Russell Bencraft, J.P., the Chairman of Directors, who unsealed the outlet pipe and enabled the gas to pass out to the town's distribution mains.

To celebrate this event a luncheon was held, at which Sir Russell Bencraft presided, being supported by Mr. C. Valon Bennett (President of the Institution of Gas Engineers), Mr. C. Dempster (Chairman of Messrs. R. & J. Dempster, Ltd., of Manchester, the Contractors), Mr. J. R. W. Alexander (Secretary of the Institution), Mr. A. W. Oke (Director), Mr. W. Robert D. Perkins, M.P., Mr. W. Croad (of Messrs. John Croad, Ltd., Portsmouth, who built the raft for the holder), Mr. R. C. S. Pearce (Director), Mr. T. H. F. Lapthorn, J.P. (Chairman, Portsmouth Gas Company), and Mr. H. S. Taylor (Chairman, Bath Gas Company).

Other Directors present included Brigadier E. M. Jack and Mr. T. Carmichael.

The CHAIRMAN, in proposing the toast of "The Contractors," said: "We placed the contract with Messrs. Dempster's with every confidence, for they are not only in the front rank of gasholder builders, a position they have held since their establishment in 1885, but they have specialized in this particular type of holder—the spirally-guided type—for upwards of 30 years, and have been responsible for some of the largest holders of this type in the country. In fact, I believe I am right in saying that they built the largest spirally-guided holder in the world. This is at Belfast, and is exactly twice the capacity of the holder you have seen to-day. We have had very pleasant relations with Messrs. Dempster's throughout the contract, and we believe that we have an excellent gasholder—one that will give long and useful service. A gasholder, however good, would be of little use without a solid foundation, and, in this connection, I would like to refer to Messrs. John Croad, Ltd., of Portsmouth, who were successful in obtaining the contract for the excavation and reinforced concrete raft in this instance, and who carried out that work, under considerable difficulty, in an excellent manner."

In giving the toast of the Contractors, Sir Russell coupled with it the name of Mr. Dempster.

A Memento of the Occasion.

Mr. DEMPSTER expressed appreciation of the remarks about his firm and spoke also of the pleasant relationships which had existed between his firm and Mr. S. E. Whitehead (Engineer and General Manager) and his staff. Mr. Dempster asked Sir Russell to accept, as a memento of the occasion, three inscribed silver dishes.

"The Visitors" was proposed by Mr. OKE, who said that besides representatives of the contractors, they had present the Chairmen and Engineers of a number of neighbouring gas undertakings.

They also had the President (Mr. C. Valon Bennett) and Secretary (Mr. J. R. W. Alexander) of the Institution of Gas Engineers. The President bore an honoured name in the Gas Industry—the names of Valon and of Bennett both being very well known in connection with gas engineering. Mr. Valon Bennett himself had not only been elected to the highest honour in that profession—the Presidency of the Institution of Gas Engineers—but was also Engineer, General Manager, and Secretary of the Rochester, Chatham, and Gillingham Gas Company—one of the most successful and progressive undertakings in the southern counties. They were glad, too, to welcome a number of professional and business friends of the town and district.

Mr. VALON BENNETT, who made the first response, commented that the Institution held the Southampton Gas Company, its Directors and officials in the highest regard; and well remembered that one of its late Engineers (Mr. Durkin) was President some years ago.

"Your present Engineer," said Mr. Valon Bennett, "is, if I may be permitted to say so, right in the very front rank of his profession, and I should like to be allowed to congratulate him upon the excellent work he has carried out since he became your chief official."

Not Built for Fun.

The new holder had not been erected for fun, but because it was necessary in order to meet the demand for gas and to ensure a constant supply at all times. "I never attend such a ceremony," continued Mr. Bennett, "without feeling how envious the suppliers of another form of energy must be, wishing that they had some form of storage so as to be prepared against accidents and difficulties which are bound to arise in connection with any public utility undertaking. May I also say how very much the Institution appreciated the interest you, Mr. Chairman, took in regard to the International Gas Union meetings which were held in Zurich in September last. You were most assiduous in your attendance at the business sessions, which is but one of the many instances typical of the interest you take in the Gas Industry."

Mr. Valon Bennett also referred to the Company's late Secretary, Mr. Jacobs, who was Hon. Secretary to the Southern Area of the Federation of Gas Employers. His successful efforts to smooth out troubles were admired by all, and his tragic passing was deeply regretted by everyone.

In 18 years the gas consumption at Southampton had increased from 874 million c.ft. to 1,569 million c.ft. The number of consumers exceeded 58,500. The capital employed was £1,073,949, and the number of employees was 938. These were gigantic figures when it was borne in mind that the population supplied was not very much more than 200,000, and it showed how everyone recognized that gas was supreme in the thousand and one uses for which it could be employed.

Future Never Brighter.

"The future of the Gas Industry," concluded Mr. Valon Bennett, "was never brighter than it is now; and the Southampton Company is a shining example of how the public can be served efficiently and economically where matters pertaining to light and heat are concerned. We most heartily congratulate you upon the manner in which this Undertaking is carried on and upon the latest addition to your plant. We trust it will not be long, because of increased business, ere you have to erect another gasholder."

Brigadier H. ST. J. L. WINTERBOTHAM, Director-General, Ordnance Survey, also responded to the toast, saying that everyone in Southampton and district had complete confidence in the Company.

Mr. LAPTHORN proposed the health of the Chairman, congratulating the Company on their superannuation and life insurance schemes, and on the excellent relations between Directors and staff.

In replying, Sir RUSSELL said they had a loyal and magnificent staff, and he was proud to be Chairman of such an excellent board of Directors.

The Gasholder.

The site for the new holder, alongside No. 9 holder, was originally occupied by the material excavated for the

tank of the latter. This was removed, trial holes were sunk, and tenders obtained for the construction of a reinforced concrete raft foundation approximately 10 ft. below works level. This work was entrusted to Messrs. John Croad, Ltd., of Portsmouth, who provided a raft 194 ft. in diameter, with a rise of 6 in. to the centre, and a thickness of 9 in. at the sides to 15 in. at the centre. A rim 18 in. thick and 11 ft. in width was formed to accommodate the tank sides, and the whole rests on medium quality gravel.

The gasholder itself consists of a spirally-guided 4-lift holder of 3½ million c.ft. capacity, in steel tank, 188 ft. 3 in. in diameter by 37 ft. 4 in. deep. It carries the usual balcony, handrails, carriages, inlet and outlet pipes, &c.

The inlet and outlet connections, of 30-in. diameter welded steel main with special expansion joints, supporting trestles, &c., were designed and erected by the Gas Company, the flow of gas in each being controlled by Holmes' 30-in. " Western " double-faced valves.

Each lift is 36 ft. 6 in. deep, and the diameters are as follow:

Inner lift	176 ft. 6 in.
Third ,,	179 ,, 5 ,,
Second ,,	182 ,, 4 ,,
Outer ,,	185 ,, 3 ,,

The gasholder, when full, throws a pressure of 14 in. water gauge. There are forty-eight spiral rails on the outer lift, the other lifts having respectively thirty-six, twenty-four, and sixteen. The carriages engaging with these rails are of the four-roller type with grease gun lubrication. The crown has a rise of 12 ft. 6 in., and is provided with Livesey manholes over the inlet and outlet pipes, with two additional manholes and 3-in. blow-off pipes and valves.

It is interesting to note that the total weight of the steel in the holder and tank amounts to 1,600 tons, while the tank contains 27,000 tons (over 6 million gallons) of water. British materials were used throughout the contract, and a considerable amount of local labour was employed.

Wizard in the Wall—

Or Toad in the Hole?

A critic reviews the new E.D.A. films. The Gas Industry, it is considered, has nothing to fear from them, but valuable lessons may be learned.

A première of the new E.D.A. films was held on Wednesday, Nov. 21, at Prince Edward's Theatre, London, before an audience of electricians. It will be remembered that the films cost £12,000 to make. Sir William Ray, introducing the programme, explained that these films are not to be shown in ordinary cinemas, but in small local halls to audiences which would be glad of any free entertainment. The reason for this explanation became obvious as the evening wore on.

There are three separate films. The underlying theme in each is that human progress depends on the increased use of electricity, and that anyone who dislikes electrical appliances is ignorant, reactionary, and stupid. The first film shows the discovery of electricity; the second illustrates the modern uses of electricity in the home; the third is a forecast of 1955, by which time it is anticipated that electricity will be more popular than it is to-day. The films are professionally produced, with a certain transatlantic slickness of touch. Their sole object is to " sell " the electrical idea to domesticated audiences. To estimate the degree of success which they are likely to achieve, a short outline of the plot must be given.

Film One: The Wizard in the Wall.

This is literally a Child's History of Electricity, told by a father to his children. In the beginning we see a number of Greeks laughing heartily at Thales for producing electric sparks. Then we see Benjamin Franklin flying his well-known kite in a thunderstorm, in spite of the warnings of a clerical friend. Next we are shown Michael Faraday registering intense interest at a lecture on electricity. A well-meaning neighbour warns him to desist from his experiments, but Faraday doggedly persists, and is finally seen in the hour of triumph producing electric current by turning a crank screwed on a table. A close-up of a pylon, a shot of an old woman turning on a wireless set, and an electric fire complete the historical section.

With the best will in the world, nobody could regard this as a piece of strong salesmanship. Instead of capitalizing the common idea of electricity as something new and magical, the producers have brought it to earth with a bump. There is one poignant scene where a frog's leg is shown being galvanized by electricity, and this suggests that " Toad in the Hole " would be a better title than " Wizard in the Wall." Never before, probably, had the audience realized that electricity was so old-fashioned. This should be a valuable lesson to the five million people who, we are told, will witness this film.

Film Two: Well, I Never!

The central figure in this drama is a feeble-minded girl who never speaks except to say " Well, I never! " at some new manifestation of electrical ingenuity. The story is told by a sophisticated woman commentator, whose *quasi*-humorous asides will not always get full marks from the type of audience for which the E.D.A. is catering.

The heroine is first shown having a quarrel with her husband because of her bad cooking. She then proceeds to iron a hole into an old-fashioned undergarment, and to explode her stove while trying to light it. After these exploits she goes to the electrical showrooms and buys a cooker and water heater. This is quite in character—you would expect it from a girl like that. In the final scene she is discovered with a lady friend having an electrical sun-bath in the drawing-room. Both ladies wear bathing costumes for the occasion.

It is hard to see how this film can do any good for electricity. Any sensible woman (and the film is intended for such) would only be exasperated by the stupidity of the nitwit on the screen. Surely it would have been sounder policy to make the heroine a normal woman—a person who can toast bread without cremating it, and iron clothes without burning them? The cardinal sin in selling is to underestimate the common sense of your prospect.

Film Three: Plenty of Time for Play.

This is an unimaginative projection of life in 1955. We see business men knocking off at three-thirty and going home in an autogiro which badly needs a silencer. There is an electrically cooked dinner and a spell of television. At the end, one of the more tedious characters holds up a book called " Plenty of Time for Play," and asks the audience to write their names on a card and give it up at the exit, so that they can have a copy mailed to them. This was the best part of the evening, and the most effective part of the film.

Pointers for the Gas Industry.

Comparing notes with other members of the audience, I found that they shared my disappointment. As a selling effort these films are negligible. The selling points of electricity are not forcibly impressed on the mind; and the films will only have goodwill value when they are shown to audiences with a low standard of entertainment.

Yet they have a valuable lesson for the Gas Industry, which is now contemplating a venture into film publicity. They illustrate two facts. First, that a great deal of care and a mint of money are needed to produce a film which will combine genuine entertainment with successful propaganda. (The electricians have tried to do this and failed.) Secondly, that the only way of producing a gas film which will not be intolerably expensive is to make it really useful to women—in other words, to make it a demonstration of cooking, laundering, or house planning in terms of the screen. Unless you have oceans of money to spend, it is a mistake to try sugaring the pill. You would only be competing with commercial films, and you would lose every time. Women like to learn about housecraft, and they prefer to have their lessons without frills. Several undertakings have proved this by filling their demonstration halls to capacity on two afternoons every week. The audiences are not interested in the history of gas. They want to know the best way of using gas to cook a new dish or to get through the family washing in record time. So when the Gas Industry takes to the screen, its aims should be purely utilitarian. It should not insist on telling the story of its life on the pretence of giving entertainment. It should get down to business and make itself useful.

We should profit by the E.D.A. experiment. They have made our mistakes for us, and paid £12,000 for doing it.

New Carbonizing Plant at Macclesfield

Inauguration of Glover-West Vertical Installation

At the inauguration, Mr. H. Curtis, Engineer and Manager at Macclesfield, and his predecessor, Mr. J. E. Blundell, now at Carlisle.

The inauguration of the new installation of Glover-West continuous vertical retorts at the Macclesfield Corporation Gas-Works took place on Thursday, Nov. 22, the ceremony being performed by the Chairman of the Gas Committee, Councillor James Nicol, C.C., in the presence of a large assembly. The company, which included the Mayor of Macclesfield, Mr. Alderman R. I. Hidderley, members and officials of the Corporation, and a number of gas engineers and other visitors, gathered in the retort house, where, after a brief introduction by the Mayor, Mr. Nicol pressed the button which set the machinery in motion.

The new installation has a capacity of 2¾ millions. The framework of the old vertical retort bench has been utilized in the construction of a set of coke-storage bunkers, above which mechanical grading plant has been installed, with bag-filling arrangements below. At the same time, accommodation for the workmen has been greatly improved. There is a new dining room, with private lockers, a shower bath, and very much better sanitary accommodation.

After the opening ceremony, luncheon, provided in the Council Chamber of the Town Hall, was presided over by Councillor Nicol, who was supported by the Mayor; Mr. F. J. West, C.B.E., J.P.; Col. W. M. Carr, O.B.E. (Vice-President of the Institution of Gas Engineers); Mr. F. G. Shaw (Engineer and Manager of the Buxton Gas Undertaking and President of the Manchester District Association of Gas Engineers); Mr. J. E. Blundell (Engineer and Manager of the Carlisle Gas Undertaking and formerly Engineer and Manager of the Macclesfield Gas Department); Mr. E. West, and members and officials of the Corporation and gas engineers.

The Toasts.

The toast of the "Borough of Macclesfield" was proposed by Mr. F. J. West, who coupled it with the name of His Worship the Mayor. He said it required a versatile mind to cover adequately such a toast as he had to propose. One should mention the trade of the Borough, its many and varied civic activities, its interesting and important geographical position, standing, as it did, midway between the beautiful scenery of the Derbyshire hills and dales and the fertile plains of Cheshire. If one spoke of the antiquity of the "loyal and ancient borough of Macclesfield," one remembered that it was described in the Doomsday service of 1066. It had charters which went back to 1261 and which, he understood, their Town Clerk had in his possession to-day. Antiquity did not necessarily go with progress. Many cities whose histories went back to antiquity were marking time to-day, but he thought that could not be said of Macclesfield. Macclesfield had married antiquity with progress.

The Mayor expressed his pleasure at Mr. West's appreciative speech, and said they were greatly honoured to be praised by the former Chief Magistrate of the great City of Manchester.

Col. Carr proposed the toast of "The Macclesfield Gas Department." He and his colleagues in the Gas Industry had a great admiration for the Macclesfield Gas Department. The Department had had a line of eminent gas engineers; and Mr. Newbigging and Mr. Blundell would agree with him when he said that Macclesfield was no less favoured in its present Engineer and Manager. Mr. Curtis was a young man, but he had already shown that he was a coming man. He had what was wanted more than anything else, breadth of outlook and courage, typified in what they had seen in the gas-works that morning. They congratulated the Gas Committee on having accepted Mr. Curtis' advice with such excellent results. He thought there was no undertaking in the country which had shown greater progress in the last ten years than the Macclesfield Gas Undertaking. He knew or no other which could show a 66% increase in the quantity of gas sold. It was indeed a marvellous result, and one of which he was sure every burgess of Macclesfield must be inordinately proud. Not only had that result been achieved, but, at the same time, the price of gas had been reduced. Their selling price to the domestic consumer was one of the very lowest in the country, and, in fact, in the world. He was speaking in general terms of average prices to prepayment and ordinary meter consumers. The average price they realized for gas last year was 5·3d. per therm. Many of them would be proud if they had achieved a similar figure, and they did not hesitate to give them and their Official the very greatest credit for that most marvellous result. Many of them were glad to see Mr. Curtis present his paper at the Annual Conference of the Institution of Gas Engineers in June on the subject of their particular method of charging for gas. That paper was very highly appreciated and was being studied by many of them who liked to think they were men of progressive ideas. Mr. Curtis had been appointed to the Council of the Manchester District Association of Gas Engineers, and they were looking forward to his help and assistance. Col. Carr said he would like to refer to the future of the Gas Industry, but he did not need to tell the Macclesfield Corporation of its possibilities. That they knew of them already was shown by the courage and initiative displayed by their Gas Department.

Col. Carr concluded his remarks by presenting to the Chairman a beautifully bound and inscribed copy of the brochure as a memento of the occasion.

Councillor Nicol, in responding to the toast, complimented Messrs. West's Gas Improvement Company, Ltd., upon the excellence of their work, and paid a warm tribute to his Engineer and Manager, Mr. Curtis, for his hard work and unremitting attention to the duties of his office, particularly during the erection of the new plant, for many of the improvements incorporated in which he had been personally responsible.

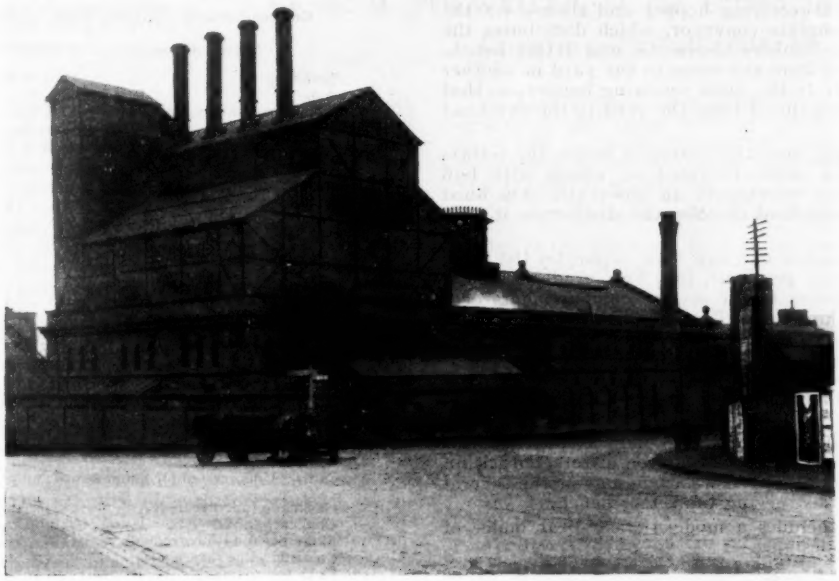
The Deputy-Mayor, Alderman T. M. Abraham, proposed the toast, "The Visitors," in reply to which Mr. F. G. Shaw congratulated them and Mr. Curtis upon the very fine installation they had seen that morning. He felt that one reason for the success of the Macclesfield Gas Undertaking was that the whole support of the Corporation was behind it. Mr. J. E. Blundell also responded and paid tribute to the capabilities of Mr. Curtis.

Early Days.

The Macclesfield Gas Undertaking has played an important part in the evolution of modern methods of carbonization. As early as 1913 Mr. W. Newbigging, then Engineer to the Undertaking, replaced the horizontal retorts by an installation of the then new Glover-West continuously operated vertical retorts. Thirty-two in number, these retorts gave an output of about 1¼ million c.ft. of gas per diem. In 1917 and 1918, Mr. J. E. Blundell, who was then Engineer to the Undertaking, introduced the system of "steaming the charge," by which method the output of the retorts and the yield of gas per ton of coal carbonized were considerably increased. As a result of his improvements and the series of investigations to which they gave rise, the design of the Glover-West retort was modified, and in 1925 the reconstruction of the retort bench on the new lines was commenced. When this reconstruction was completed in 1927 the capacity of the retort bench was over 2 million c.ft. per diem.

By 1932 the capacity of the plant was becoming insufficient to meet the demand of a maximum day's requirements, and as some of the retorts were approaching the condition in which resetting was required, the Engineer, Mr. H. Curtis, recommended the installation of an entirely

new retort bench. Tenders were invited and the contract was placed with Messrs. West's Gas Improvement Company, Manchester, for the installation of 32 retorts of their 40-46-in. pattern of the latest design, arranged for the process of "steaming *in situ*," with a nominal daily capacity of 2,800,000 c.ft. when making gas at a calorific value of 420-430 B.Th.U. per c.ft.



THE 1925 INSTALLATION OF GLOVER-WEST VERTICAL RETORTS AT THE MACCLESFIELD CORPORATION GAS-WORKS.

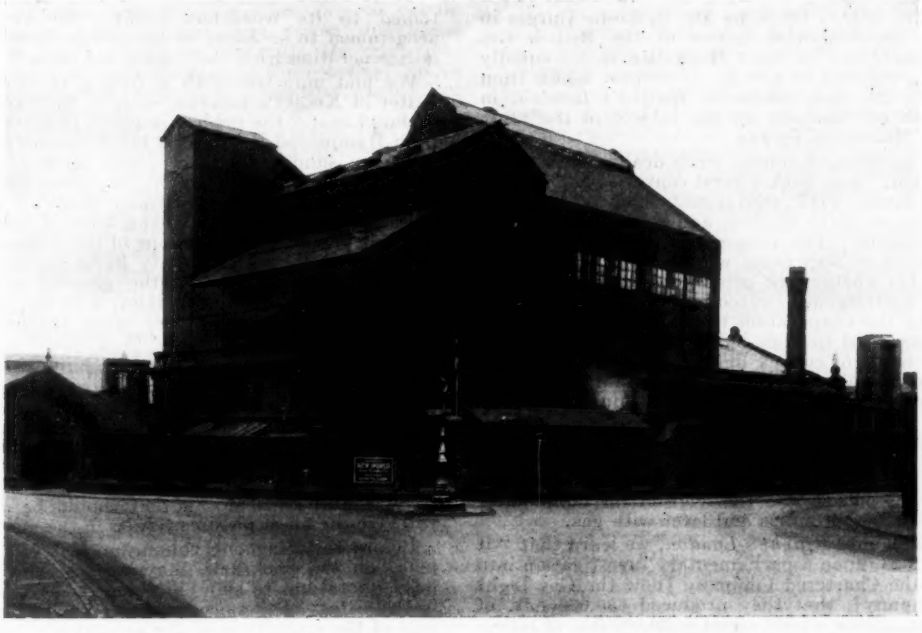
The New Installation.

The new installation comprises 32 retorts of the Glover-West 40-46-in. new model arranged in heating units of four retorts each, built on the site originally occupied by horizontal retort settings, and laid at right angles to the original bench of vertical retorts.

Gas to heat the retorts is generated in three producer-gas generators which deliver fuel gas into a common flue running the full length of the retort bench, so that any or all of the producers supply gas to all or any of the retort units. These producers are equipped with steam pressure plant to enable the use of the low quality small coke for this purpose, releasing high-grade coke for sale.

The building of the new installation has been carried out during the summer months, which enabled a proportion of the equipment of the obsolete retort bench to be reconditioned and used in the construction of the new plant.

The new coke extractor driving gear is actuated by an electric motor with a totally enclosed steam engine as a stand-by. This mechanism is enclosed in a housing arranged inside the retort house, and thus protected from the destructive action of dust.



THE INSTALLATION AS IT NOW APPEARS, WITH THE NEW GLOVER-WEST VERTICAL RETORTS PLACED AT RIGHT-ANGLES TO THE EARLIER PLANT.

The existing retort house walls are extended to a sufficient height to accommodate the new installation in the familiar steel-framed brick-panelled design. Platforms and staircases and ample space and light are provided so that

the attention to the working parts of the installation can be carried out with convenience and efficiency.

Coal is brought to the retort house in carts from the railway siding and discharged into a receiving hopper of three tons capacity placed with its mouth at ground level. From this hopper the coal is elevated and delivered either to an auxiliary storage hopper arranged inside the shell of the original vertical retort bench or direct to the elevator and pushplate conveyor. A chute is provided from the bottom of this auxiliary hopper to enable coal to be re-delivered to the coal-receiving hopper and thence via the elevator to the pushplate conveyor, which distributes the coal in the storage bunkers above the new retort bench. Coal is also received from the crane in the yard in another hopper with a chute to the main receiving hopper, so that supplies can be taken direct from the yard to the overhead storage bunkers.

Coke is discharged from the chambers below the retorts into bottom-opening skips, mounted on wheels with ball bearings. These are wheeled to an automatic skip hoist which elevates a skip load of coke and discharges it to a West coke grader.

This machine, which is of a new type, separates the coke, at the rate of 10 tons per hour, into four grades which it conveys and distributes to the several compartments of a bunker formed within the shell of the dismantled original retort bench. Outlet doors to carts and for bag-filling are arranged in the bottom of the bunkers, so that coke is normally taken straight from the retort bench to the conveyances of the purchasers with a minimum of handling and breakage.

Auxiliary coal and coke-handling plant is provided for by the installation of a new steam-driven lift erected within the retort house and arranged with landings at the several levels of the platforms serving the retort bench.

The installation includes a modern waste-heat boiler of Spencer-Bonecourt design.

Results.

The new installation was actually brought into commission on June 16 and 17, 1934, two settings being put into operation. The old installation was completely shut down and normal operation was established in the new retorts by July 7.

The following details are taken from the records for the month of October:

Results for Two Weekly Periods.

[Corrected to normal temperature and pressure.]

Coal carbonized—Manvers Main, washed doubles.

Proximate analysis of air-dried sample.

Moisture	3·86 %
Ash	3·10 ,,
Volatile organic matter	35·73 ,,
Fixed carbon	59·31 ,,
Calorific value	14,250 B Th.U. per lb. dry

—	Week Ended Oct. 12.	Week Ended Oct. 19.
Gas made per ton of coal carbonized —		
C.ft.	25,750	28,480
Therms	110	119
Calorific value of gas: B.Th.U. per c.ft. gross	427·4	418
Make per retort—		
C ft.	96,940	94,680
Therms	410	395·7
Fuel consumption, % on weight of coal carbonized	15·9%	16·0%

Results Recorded in the Carbonizing Book for the Month of October.

[Uncorrected for temperature and pressure.]

Gas made (uncorrected)	39,118,000	c.ft.
Coal carbonized	1,554	tons 11 cwt.
Make per ton (uncorrected)	25,163	c ft.
Calorific value (average)	420·45	B.Th.U./c.ft.
Coke to producers	246	tons 5 cwt.
Do. % on coal carbonized	15·84	
Waste-heat recovery—		
Water evaporated	225,775	gallons
Per lb. of fuel to producers	4·09	

Ancient Lights

The peeps into history taken by Dr. E. Leslie Burgin in the course of his delightful speech at the British Gas Federation dinner, and by Lord Macmillan in his equally felicitous reply, induced us to take down once again from the bookshelves the first volume of *Knight's London*, in order to refresh our memory on the subject of the early lighting of the Metropolis by gas.

The book in question, of course, when dealing with "The Lights of London," goes back several centuries before that, to the reign of Henry VIII., who is said to have "hung up, of great thieves, of petty thieves, and rogues, three score and twelve thousand." The author remarks that this was a wholesale method of dispensing with a preventive police, though he doubts whether the prison and the gallows were cheaper than lighting and watching. In 1694 a licence was granted by the Corporation to certain persons "concerned and interested in glass-lights, commonly called or known by the name of convex lights," for the sole supply of the lights in all public places in the city, for twenty-one years. But at the end of that time nothing more was heard of the glass-lights or convex lights, and, instead, householders were required, on dark winter nights, to hang out lanthorns provided with candles. Half-way through the next century (in 1762) the Westminster Paving and Lighting Act was passed, and the reign of the lamplighter began, first with the oil lamps and later with gas.

Dipping further into *Knight's London*, we learn that "it was shown in 1823, upon a parliamentary investigation into the affairs of the Chartered Company [now the Gas Light and Coke Company], that they produced 680,000 c.ft. of gas every night, giving a light equal to 30,000 lbs. of tallow candles. The consumption of the Metropolis in 1841 was reckoned at nearly 9,000,000 c.ft. in twenty-four hours, so that the production of gas in London every night was equal to the light of 400,000 lbs. of tallow candles." We should not now care to compare London's magnificent public gas lighting in terms of "pounds of tallow candles," though it is not so very long since calorific value succeeded candle-power as the standard for measuring the quality of the gas. But though we still recognize the wondrous efficiency of our public gas lighting, we have become accustomed to its wondrous beauty, as we have become accustomed to so many of the things that distinguish our own generation from the "good old days."

We find ourselves with a feeling of envy towards the writer of *Knight's London*, who, in the early days of gas, declared that "the noblest prospect in the world is London from Hampstead Heath on a bright winter's evening. The stars are shining in heaven, but there are thousands of earthly stars glittering in the city there spread before us; and as we look into any small space of that wondrous illumination, we can trace long lines of light losing themselves in the general splendour of the distance, and we can see the dim shapes of mighty buildings afar off, showing their dark masses amidst the glowing atmosphere that hangs over the Capital for miles, with the edges of flickering clouds gilded as if they were touched by the first sunlight."

No more than some sixty years have passed since these words were penned, but how few now have either leisure or inclination to dwell upon the beauty of the efficient gas-lights which enable them to put a strain upon their speedometers when motoring through the streets during the hours of darkness! Now the test is not, "What does it look like?" but "What will it do?" Well, good gas street lighting will do all that should be asked of it. It will give the finest possible results in the most reliable form.

Before restoring our volume of *Knight's London* to its place on the bookshelf, may we be permitted one more brief quotation, to show how long a period is sixty years in the history of the gas supply of the Metropolis? "Some idea of the magnitude of the present gas supply of London and the suburbs may be gathered from the fact that the Metropolitan lamps extend [that is, they extended sixty years ago] from Forest Gate, beyond Stratford in Essex, to Hampton in the far west, and from Hampstead Heath and Highgate in the north to the end of Upper Norwood in Surrey. The gas is chiefly supplied by nine large companies, whose published returns in 1873 show an authorized capital of nearly ten and a half millions, of which more than eight millions are paid up."

A. H.

Further American Investigations of the Gum Problem

In a paper before the Technical Section of the A.G.A. Annual Conference, 1934, the author expresses the opinion that it will be impossible for appliances in the distribution system to be free from gum stoppages unless the nitric oxide is completely removed from the gas at the works.

By W. H. FULWEILER, of the United Gas Improvement Company, Philadelphia, Pa.

The work of our research programme on the factors affecting the formation of vapour phase gum deposits had progressed very rapidly during the early part of this year, and we had confidently hoped that we might, at this time, be in a position to present a fairly complete picture of the subject.

During the summer delays occurred due to the pressure of emergency work with the result that there are a number of features in our programme which we have not been able to complete. We can, therefore, only report a fair amount of progress.

Determination of NO.

This phase of the work we believe is almost completed except for a few checks for confirmation.

We have studied the reactions taking place during the test by preparing synthetic mixtures of gases with a known content of NO and determining the effect of the various added constituents on the formation of NO_2 and have also repeated these determinations starting with NO_2 and determining the rapidity of gum formation. In this way, we have been able to discriminate between hydrocarbons that were catalysts for the NO-NO_2 reaction and those which merely reacted with the NO_2 to form gum. In much of the work the results were followed by examining the mixture with the ultra microscope.

We believe that we have identified butadiene as the more important catalyst for the reaction NO to NO_2. We have not, however, completed our identification of the material which, for lack of a better name, we are calling the "rapid reactant" which combines very rapidly with the NO_2 formed by the first reaction, apparently forming gum and thus resulting in low readings. This appears to occur with certain types of carburetted water gas and oil gas. The present evidence points very strongly to cyclopentadiene as being responsible for this effect.

An important observation for which we have as yet no definite explanation is the fact that unless these constituents exist above a certain minimum concentration, they seem to have very little effect on the reaction, but as soon as this minimum concentration is exceeded, their effect is very greatly increased.

It would appear, in light of the above results, that where our present test gives low results due to the presence of the "rapid reactant" for the gum formation the probabilities are that such gases will give very much less trouble in the distribution system owing to the bulk of the NO being used up, with the resulting formation of gum in the holders before the gas leaves the plant.

While this work has been carried on primarily in the laboratory we are continuing the work in the plant, where we are fortunately in a position to have available a full-sized carburetted water gas set with its own relief holder. We are studying the effect of the more important operating variables on the production of NO and the existence of the various unsaturated hydrocarbons which may have an effect on the determination of NO. This same work is also being carried out on oil gases made by different processes.

Our work with the magneto-optic method as an absolute method for the determination of NO has not progressed as fast as we had hoped.

We have been working in co-operation with the Morris Arboretum of the University of Pennsylvania, and our work during the year was devoted to an intensive study of methods to render the readings of the apparatus more definite. This has been accomplished by certain modifications in the circuit and the use of a continuous light source interrupted at the appropriate time by Kerr cells. As we see it, the present problem requires some very involved calculations and adjustments of the characteristics of the circuit utilized in the apparatus. The time intervals are of the order of 10^{-9} seconds and a number of factors have to be considered that are not usually appreciable. It will probably require another year to work out these details.

The men working on the problem, however, are very hopeful that this method will eventually be of service in the determination of small amounts of impurities such as NO.

We have finished seven pieces of the automatic recording apparatus and three more are under construction. We have had the usual amount of small troubles, primarily mechanical in nature, which have somewhat delayed the delivery of the apparatus.

Time Required to Stop Pilots.

One of the questions that we are frequently asked is how fast do pilots stop up with various concentrations of NO in the gas. This is a very difficult question to answer, as there are so many factors which appear to have an influence on the rate at which pilots are stopped up with vapour phase gum. Among these are the following:

(1) The concentration of NO.
(2) The prior history of the gas—that is to say, its age before the sample is taken.
(3) The length of time and probably to some extent the conditions under which the gas is stored after it is received and before it reaches the pilot under test.
(4) The characteristics of the particular pilots used.
(5) The pressure of the gas.

We have, in the past several years, made a great many of these tests. Certain individual pilots even with different adjusting screws appear to be more prone to stoppage than others. For this reason, we believe that probably ten pilots should be used in order to obtain an average result.

It is important that a uniform standard pressure should be maintained on the pilots under test if comparable results are desired, and that the temperatures should also be maintained as uniformly as possible. There is evidence to indicate that at times moisture may condense on the adjusting needle if the temperature drops suddenly and thus cause the pilot to go out, and that after the temperature rises this moisture will evaporate, permitting the pilot to be re-lighted.

In our early work, the condition of the pilots was estimated by eye, but we now measure the amount of gas passed by the group of pilots with a test meter. When the pilots are first set they are adjusted so that the average rate is 0·25 c.ft. per pilot per hour. The rate is then determined at intervals giving what appears to be a more accurate valuation of the rate of stoppage.

For each concentration of NO there appears to be an optimum time of storage which yields particles of the maximum stopping power. In general, the higher the concentration of NO the more rapidly will pilot stopping particles form, and the converse is equally true that with low concentrations of NO a greater length of time is required before the particles have reached a size at which they are effective in causing pilot stoppages.

A summary of our tests is given in the following table:

Effect of NO Concentration and Storage Time on Time Required to Extinguish Pilots.

NO Concentration.	Optimum Storage Time.	Time Required to Extinguish.
Grains per Million C.Ft.	Hours.	Hours.
400 to 700	1 to 2	5 to 8
100 to 200	4 to 6	80 to 100
15 to 30	8 to 10	100 to 150

We have very little data on gases containing less than 15 grains of NO per million c.ft., due to the difficulty of securing samples of gas that are uniformly of this concentration over a sufficient length of time. We can report, however, that samples of gas purified in the laboratory with our oxide process under carefully controlled conditions have burned, after 22 hours' storage, for 1,000 hours with a drop in the flow of only 3%.

In connection with the use of pilots as a standard test, it should be remembered that after the flow in a pilot decreases to about one-quarter of the normal flow, the pilot, for all practical purposes, may be considered as unsatisfactory, as under these conditions the flame is likely to be extinguished by the slightest draught, and we believe that

the results secured when using pilots will be found much more concordant if we utilize the time required for the flow to decrease to 25% of the original setting, for comparative purposes.

Use of Filters.

One of the more important recent developments has been our discovery that where gas which had contained NO and had formed particles, was freed from the NO and was then subjected to very careful filtration to remove the visible particles, the gas still contained particles too small to be visible in the ultra microscope. If this gas is stored for a reasonable length of time these very small particles will apparently coalesce and increase in size to a point where they will again extinguish a pilot.

This very largely explains our difficulty in interpreting conditions where, although the gas apparently contained very few visible particles, yet stoppages would occur in the pilots, and it also very clearly pointed out that to be useful filters must be attached to the individual appliances so that no appreciable time elapses between the filtration of the gas and its consumption in the appliance.

Methods of Removal of NO.

We are, of course, continuing our study in the search for improved methods or processes for the complete removal of NO. We have nothing as yet that appears to do any better work than our oxide process when operated in accordance with our patents.* It must be remembered that when we impose a double duty on our purifiers—*i.e.*, that of removing both the hydrogen sulphide and the NO—we must expect some additional operating costs.

In most plants where adequate purification capacity is provided the additional cost of operating oxide purifiers for the removal of NO is confined to the necessity of closer supervision, and from one to two extra changes of oxide per year, together with proper treatment of the spent oxide.

We estimate that the average cost of operating our process should not exceed 0·15 c. per 1,000 c.ft. above the usual purification costs, and that this increased production cost will be offset many times by the saving in complaint expense and the giving of better service to the consumer.

Limit for NO in Gas.

As we continue our work on the effect of small quantities of NO we are more and more impressed by the fact that, while a certain amount of NO will undoubtedly be used up and deposited as gum in the distribution system, yet we do not believe that it will be possible for the appliances in the distribution system to be free from gum stoppages unless there is no NO in the gas. Every estimate that we have made, and they have been decreasing in concentration, has on further trial proved to be too high. For a relatively long period we have maintained the NO in the outlet gas at one of our plants in Philadelphia below 15 grains per million c.ft. The stoppages decreased quite satisfactorily but they were not eliminated. We have reason to believe that after such a long period with fairly high main temperatures that the greater part of the NO in unstable combination in the interior of the mains should have been removed. It may be, however, that the stoppages were due in larger part than we anticipate to this residual NO given off by the mains.

There appears to be some evidence indicating that with the same amount of residual NO straight coke oven gas will cause a more rapid stoppage of pilots under average conditions than a mixture of coke oven gas with carburetted water gas.

In studying the appliance stoppages that occur in the distribution system we labour under the difficulty that, even with gas coming from the plant substantially free from NO, some NO may be given off by the deposits in the main. Such NO is given off in very small quantities so that it goes through NO_2 and forms gum without appearing as NO in detectable quantities, and the gum particles thus formed are frequently too small to be observed in the ultra microscope unless the gas is stored for a number of hours. The perfection of electrical methods for estimating the occurrence of the invisible particles would seem to be the key to our further progress on this phase of the work.

Progress in the Development of Non-Stop Controls.

The Physical Laboratory has continued its work on the development of control devices that are less susceptible to stoppage by gum particles. We reported last spring the development of a new type of pilot control which has been under test since Dec. 5, 1933. This test was stopped on Oct. 9 after 307 days' operation on gas to which NO had been added, so that a Rutz lighter was extinguished in 24 hours. Two of the pilots had been removed for exhibition purposes and the 22 remaining pilots showed a flow of 83% of the normal flow. We estimate that this would be equivalent to 1,300 days' operation before the flow of the test pilots had decreased to 25%.

A modification of the grooved disc type of control in which the length of the groove remains constant while the cross-section is varied by the control mechanism is in commercial production, and some thousand of these appliances are expected to be ready for delivery within the next month or so. These pilots can be used where a flow between 1 and 5 c.ft. per hour is desired.

A major development during the past year has been the construction of a filter designed for use on individual appliances. This filter has a capacity up to 5 c.ft. per hour and is available for any type of service within this capacity. It is especially adapted for use on water heater pilots, house heater pilots, and the full flow of gas for refrigerators.

A refrigerator equipped with this filter has been in use for 187 days and is still operating normally. This is operating on doctored gas which causes outages of the ordinary equipment in 6 days for the pilots, 27 days for the orifices, and 40 days for the thermostats.

We believe that the use of these individual filters is probably the most immediate answer to the gum problem for plants that are not in a position to install the necessary remedial processes in their operating departments, as our experiments previously mentioned in this paper indicate that a properly designed filter will give satisfactory protection if it is installed immediately adjacent to the point where the gas is used.

* U.S. Patent No. 1,976,704.

Steaming in Horizontal Retorts

In our Editorial Columns to-day comment is made on the Report of the Fuel Research Board for the year ended March 31 last, with particular reference to steaming in horizontal gas retorts. The accompanying table, extracted from the Report, is a summary of the best results obtained during steaming experiments at the Fuel Research Station with varying volumes of heating gas re-circulated through the setting:

Summary of Best Results Obtained During Steaming Experiments at the Fuel Research Station.

Throughput per Day.	Weight of Charge.	Period of Steaming.	Steam Supplied.		Coke to Producer per Ton of Coal as Charged.	Gas Yield per Ton of Coal as Charged.			Gas Therms per Retort per Day.	Remarks.
			Per Ton of Coal as Charged.	Per Charge per Hour.		Volume.	Calorific Value.	Therms.		
Tons.	Cwt.	Hours.	Lbs.	Lbs.	Cwt.	C.Ft.	B.Th.U. per C.Ft.			
10·0	12·5	*Nil*	..	..	4·0	13,780	556	76·6	95·8	Normal volume heating gas, 32,000 c.ft. per hour
10·0	12·0	3	128·5	25·7	4·2	16,980	512	86·9	108·6	Normal volume heating gas, 32,000 c.ft. per hour
10·0	12·5	3	211·0	43·9	4·8	18,000	500	90·0	112·5	Volume of heating gas, 47,400 c.ft. per hour
11·0	12·5	1	102·8	64·2	4·6	17,000	507	86·2	118·5	Volume of heating gas, 46,000 c.ft. per hour
14·5	12·5	1	43·3	27·0	4·3	15,270	537	82·0	148·6	Volume of heating gas, 78,000 c.ft. per hour

Modern Legislation for the Gas Industry

By George Evetts, M.Inst.C.E., M.Cons.E.

No. 6

THE Author continues his review summarizing the position of legislation up to the present time as it affects the Gas Industry to-day. Previous articles in this series appeared on Oct. 24 and 31, and Nov. 7, 14, and 21.

Domestic and Administrative.—Contd.

Effect of Differential on Dividends.

In the case of maximum dividend Undertakings, this matter is simple. If the inner maximum is 12d. per therm and the differential is 3d., then the dividend authorization is unaffected as long as gas is not sold in the outer area at more than 3d. in excess and the price is not more than 15d. If there are two maximum prices—*i.e.*, 12d. in the inner area and 15d. in the outer—then the maximum dividend is authorized even though the difference is more than 3d.—*i.e.*, the selling prices may be 10d. and 14d. respectively. It all depends on the wording of the Statute.

In the case of sliding scale Undertakings, the matter is equally simple. If the Statute gives a standard price *plus* a differential, then the usual wording is to the effect that the differential does not affect the dividend—*i.e.*, it is ruled by the inner area price. Occasionally, however, amalgamations have been effected (*e.g.*, Wandsworth in 1912) where the capital was geographically segregated and the dividends in each class of capital were related to the selling price in that area, with the proviso that the Company were obliged to sell gas according to the relative scale prescribed in the Statute—*i.e.*, the differential was compulsory. The compulsory element, however, was incidental. The separate dividends could still have been dependent on the price in a particular area and the differentials left optional.

With regard to basic prices, there is considerable complication due to a certain lack of appreciation as to the operations of basic price. The various classes can be divided broadly as follows:

1. Undertakings carrying multiple basic prices with a distinct consumers' benefit in each area, calculated as separate elements, then added, and the consumers' benefit of the Undertaking is the total; this total rules the dividend. In addition, there would be a Clause prescribing the powers of differential charge.
   Among this class are Bath, Newcastle, Romford, and Sheffield.
2. Undertakings carrying a basic price representing the loaded average of the areas at the time of the application and accompanied by a Clause prescribing the power of differential charge.
   In effect this is the same as class (1) at the outset, but only continues the same as long as the conditions between different areas remain comparable.
3. The famous "Dudley" Clause which has from time to time been the despair of Counsel, Agents, and Committees. This Clause is easier to understand than explain, but briefly it is as follows:
   The excess price is not taken into account in calculating the consumers' benefit, and is, therefore, deducted from the gross gas receipts in order to get the theoretical receipts, from which the consumers' benefit is calculated. This excess price is arrived at by adding two elements:
   (*a*) The gas sold (A therms) to small consumers at the full differential (*d*)—*i.e.*, at the nominal price operating in the outer area.
   (*b*) The gas sold (B therms) to other consumers at prices lower than the nominal, at a figure lower than the full difference. This lower figure (d_1) bears the same proportion to the full differential as the average of the gas sold at reduced rates bears to the ordinary domestic rate.
   The "product of the differential" is then $A \times d + B \times d_1$.
   This Clause has never found favour, and although it was an attempt on the part of the legislation to prevent large dividend authorizations by selling gas at big discounts in an area with a high permissible differential, yet it does not have this effect in practice. The Clause can now be regarded as out of date.
4. The "Dudley" pattern of Clause reduced to a simpler form. For example, the Grantham Order provides that the "excess price" must be deducted in order to obtain the theoretical revenue, and this term is defined as being such a sum as bears the same proportion to the total receipts in the outer area as the nominal differential bears to the full nominal price in the outer area. The effect is similar to the "Dudley" Clause, because it reduces the consumers' benefit by not allowing the full differential charge to operate. For example, if the differential is 2d. and the nominal price in the outer area is 1s., the differential is one-sixth of the total. The Clause prescribes that one-sixth of the revenue of the outer area is true differential, and must be deducted to obtain what would be the revenue if gas were sold at the same price as in the inner area.
5. The simplest form of all, as far as words go, is that embodied in the South Suburban Act of 1932 (Section 45). This Clause provides that, in arriving at the consumers' benefit, the sums actually paid for gas in excess of what would have been paid had the price been the same as in the principal area, are not be taken into acount—*i.e.*, for calculating the consumers' benefit the differential is assumed not to exist. There are several interpretations of this Clause:
   (*a*) Assume that all gas in the outer area is sold at the inner area average price—*i.e.*, the outer area discounts are taken as the same per therm as the inner area.
   (*b*) That the total differential to ordinary domestic consumers should be deducted from the actual revenue in the outer area. This involves the assumption that all the gas is sold at an addition equal to the differential, which may be favourable or unfavourable to the authorization.
   (*c*) The domestic consumers can be taken as a group and the full differential deducted, adjusting for such quantity discounts as may come within the domestic scale. Each other class is treated in the same way (and in case of special contracts each consumer), and the total effect of the differential calculated. This is a laborious and cumbersome method, and involves the assumption that one knows exactly what would be charged to each large consumer if he were in the principal area.
   (*d*) Adopt the meaning outlined in the Grantham Clause—*i.e.*, if the nominal differential were 2d. out of 1s. total price, assume that one-sixth of the revenue of the outer area is due to the differential.
   (*e*) Take the same proportionate discount on the outer area as the inner. Thus, if gas is sold at 10d. nominal in the inner area, and the net receipts are 9d. then the overall discount is 10%. Therefore, the consumers' benefit in the outer area is 10% of 12d. = 1·2d., and we have it that the total consumers' benefit is 1d. multiplied by the therms in the inner area *plus* 1·2d. multiplied by the therms in the outer area.

There are combinations of the above interpretations, but

the results are not greatly different, and either (*c*) or (*d*) appear to be methods that can be defended.

Reference has already been made to the adjustment to the consumers' benefit and consequent dividend authorization introduced by the "Wrottesley" Clause, and in most Statutes gas sold in bulk to another undertaker is not to be taken into account for the calculation of consumers' benefit.

Public Lamps.

The supply of gas by Companies to Local Authorities is dealt with in Sections 24 to 27 of the Gas-Works Clauses Act, 1871. Section 24 prescribes that undertakers are to supply gas to any public lamps within a distance of 50 yards from a main. The price shall be settled by agreement between the Local Authorities and the undertakers, and failing this by arbitration, taking into consideration the circumstances and the price charged to private consumers in the district. The writer is unable to find any general legislation giving Local Authorities the right to purchase gas at rates lower than the ordinary lighting consumer, but many special Acts compel the undertaker to sell gas for public lighting at a discount, and in some Acts it is specified that the Local Authority is to be supplied at the lowest price ruling for any ordinary consumers. This provision may not have been objectionable in the past, but, owing to the development of industrial sales, it is very onerous to-day, and it is necessary that this right be restricted to the price paid for domestic consumption only. It is to be noted that the 1934 Act in Section 6, Sub-Section (3), relieves the Undertaking of these obligations in respect of gas sold under special contract. Therefore, if the Undertaking wishes to avoid difficulty in relation to the price charged for public lamps, it must be prepared to make special contracts in every case where such difficulties are likely to arise.

Section 25 of the 1871 Act prescribes that the gas for public lighting shall be consumed by meter at the option either of the Local Authority or the undertakers. In the event of a meter being required, the cost of providing and fixing it is to be paid for by the party requiring it. If the gas supplied to public lamps is to be arrived at by calculation based on average indication of meters, the undertakers are to provide pressure regulators and burners to the specification of the Local Authority, so as to get uniformity of consumption between metered and unmetered lamps. Section 26 provides that in any case either side may at their own expense fix governors to each lamp, and that either party shall be entitled to have access to such governors for the purpose of examination.

Section 27 provides that difficulties arising between the undertakers and the Local Authority shall be settled by arbitration.

If the Gas Undertaking desires, it can supply gas for public lighting at special rates providing the "equality" clause is observed. Supposing, for instance, it can be proved that a discount of 30% is justified, then this discount can be granted assuming that the Undertaking would be prepared to supply a similar consumer on like terms. In practice, of course, it is impossible to duplicate a public lighting consumer—*i.e.*, one who takes a large number of single light supplies, one off each service, and taking the gas during the night hours only, but at the same time it should not be difficult to prove that the discount is economically sound and does not involve subsidy by other consumers. It generally happens that a price for public lighting comprises:

(*a*) Gas.
(*b*) Lighting, extinguishing, maintenance, &c.

There is nothing to prevent the Undertaking from treating the gas as sold as a reasonable discount, and the balance as the receipts for the other services, even if the provision of these services involves a loss. It might happen that, if the gross receipts were reduced by the actual cost of maintenance, the balance, if treated as the payment for gas, might result in an unreasonably high discount, and in these circumstances break the spirit of the "equality" clause, or impinge on some other provision in the Company's Statute. It would not be unreasonable to regard a loss on this maintenance expense as a debit against advertising, but the important point here is that basic price Undertakings must have a definite policy as to what part of the total receipts represents gas and what represents maintenance. If an Undertaking is not shackled by any limitations of price at which gas is to be sold for public lighting, then it is obviously to its interest to assume that gas is sold as cheaply as possible, even though this may involve a profit on the maintenance. Therefore, a middle line is to be taken forming a compromise between the limitations of the Statute (if any) and a reasonable selling price for gas.

Letting of Appliances, &c.

In the various Acts not only general but specific, Parliament has legalized the right of a Gas Undertaking to extend beyond the mere supply of gas. It has recognized that, provided the consumer is adequately safeguarded, it is to everybody's interest that the Undertakings should act as ironmongers, as it were. In addition to meters, undertakers are empowered to supply cooking stoves and other fittings and various kinds of gas consuming appliances.

In the case of slot consumers the majority of Undertakings have a Clause limiting the surcharge, the figures of which have been given previously. In the case of the renting of ordinary meters, however, the terms can be agreed between the Undertaking and the consumer. Actually, the terms are not so agreed, because the Company prescribe a hire rate, and the consumer if he is dissatisfied with such rate, can provide his own meter. In this event, of course, the meter has to go through the same test for accuracy as if the Undertaking had provided it.

The general right to let stoves on hire and fittings of any description is granted in Section 18 of the Act of 1871, and this logically embraces the prepayment meter consumer, although such consumer was introduced at a later date. Many Undertakings have additional powers to supply "engines, stoves, ranges, pipes, and other gas fittings for lighting, motive, heating, ventilating, cooking, or any other purposes." This is a Model Bill Clause, and enables the Undertaking to cater for practically any class of consumer. Thus, if desired, the undertaker could let out fish frying ranges fixed complete on a 10-year hire purchase scheme. The undertaker can provide all materials and work necessary in connection with the fixing, repair, or removal of such appliances. Special provisos are added to this Clause, in the case of Local Authorities, in regard to the charges, prescribing that these articles must be hired at economical rates.

The various protective powers necessary respecting these appliances in regard to debt, access to premises, removal where supply is discontinued, and so on, are provided for by general and special legislation. In connection with these appliances most Undertakings have two Model Bill Clauses requiring consumers—

(*a*) To use anti-fluctuators with gas engines.
(*b*) To provide efficient valves where high-pressure air is used.

The 1934 Act combines these two Clauses in Section 25, and somewhat enlarges the scope. Therefore it is no longer necessary for Undertakings to get these Clauses in Special Acts or Orders.

Legislation Special to the Metropolis.

It is not generally recognized that it is only in the Metropolis that the statutory area is actually a monopoly. In other Acts and Orders, although an Undertaking is given the right to open the roads in a specified area, Parliament makes no promise that another Company shall not be given the whole or parts of that area in which to do likewise. In practice this has never arisen, of course, but, in all modern Orders, extensions of area are granted with the proviso that if the areas in question have not been supplied within five years of the date of the Order, nothing is to prevent another Undertaking from making application for the area. There is, outside the Metropolis, nothing to prevent a non-statutory Undertaking from either competing in business with the statutory one, or commencing in a section of the area not supplied by the statutory Undertaking. In the Metropolitan Gas Act, 1860, however, the following appears: "And no other Company or person than the Company to whom such limits are for the time being assigned or shall hereafter be assigned shall supply gas for sale within the said limits until authorized by Parliament so to do."

This part of the Act was principally to settle limits of districts about which there had been previous dispute, and the Companies concerned, 13 in all, finally agreed upon the boundaries. The effect, therefore, was to give to each Company a monopoly in its own district. These 13 Companies at a later stage amalgamated in various groups, which became what are now known as the "London Companies," viz.: The Gas Light and Coke Company, the South Metropolitan Gas Company, and the Commercial Gas Company. These districts were to be subject to triennial revision. The Metropolis had a special Clause relating to obligation of supply, and any Company was bound to supply any premises or street which lay within 50 yards of existing mains. The prospective consumer had to contract for not less than two years to pay gas rates up to an amount not exceeding 20% upon the outlay. The Company had to provide meters at a rent not exceeding 10% on the net cost of such meter. It should be noted that

the Undertaking was not compelled to supply more than one meter for each consumer occupying a separate apartment or dwelling, nor any meter exceeding a five-light. The Undertakings were further compelled to light public lamps when required by the Local Authority, according to terms of the contract made with such Local Authority, but they were not compelled to light lamps at a greater distance apart than 75 yards. Local Authorities are empowered to provide their own lamp posts, &c. There was a Clause limiting the charge for gas supplied to public lamps, but this has been superseded by Clauses in the separate Special Acts. Clauses were provided giving Companies the usual protection for claiming deposits, recovery of monies, &c. The Gas Companies were under obligation to protect other statutory undertakers, and protective Clauses were inserted relating to the laying of pipes, liability to contamination of water, &c.

The Metropolis Gas (Prepayment Meter) Act of 1900 prescribed the charges to be made for prepayment meters, and the obligations of the Companies in connection therewith, but these have been varied subsequently.

Liability for Escape.

Attention has already been drawn to the liability of gas undertakers in respect to the fouling of water. By Section 21 of the Act of 1847, the gas undertaker shall forfeit for each offence the sum of £200, if any of his *processes* causes fouling of the water in any stream, reservoir, &c. A similar provision is in Section 68 of the Public Health Act, forfeiture for each offence being £200, and after the expiration of 24 hours' notice that such fouling is going on, a further sum of £20 for each day during which the offence is continued. Under Section 25 of the 1847 Act, the undertaker is liable to a penalty for the fouling of any water within the limits of supply by contamination from *gas;* the penalty for each offence is £20, and a further sum not exceeding £10 per day during which the offence is continued. Further Clauses dealing with this matter are Nos. 26 to 28.

Section 29 of the same Act provides that nothing in the general or special Act shall prevent an undertaker from being liable to an indictment for nuisance, or to any other legal proceedings to which they may be liable in consequence of making or supplying gas. Section 24 deals with escape after notice. It provides that immediately on receipt of notice in writing, an escape must be remedied, and if this is not prevented within 24 hours after service of such notice, and the cause of complaint removed, they shall be liable to forfeit £5 for each day during which the gas shall be suffered to escape after the expiration of the said 24 hours.

Difficulties in Practice.

These Clauses sound comparatively simple, and although the principle is simple, the difficulties in practice are many and varied. In short, the Gas Undertaking is not allowed to commit a nuisance because it is authorized by Parliament to operate a gas-works and open streets for the purpose of laying pipes. Therefore, any act for which the Company is responsible and which may cause damage is indictable, and, further, certain acts which *may* cause damage are liable to fines under certain conditions. Take, for instance, Section 24, referring to escapes. An escape of gas may do no damage, but if it can be proved that the Undertaking have not repaired it within 24 hours of knowing of its existence, they can be fined. Supposing there is an escape about which no notice has been given, and suppose this escape causes damage to persons or property by poisoning or explosion, if any default can be proved against the Undertaking, they are liable. Logically a Gas Undertaking is expected to do all in its power to prevent escape of gas; not only to prevent it, but to keep up reasonable inspection of their mains and service pipes, so as to enable them to detect where there is an escape, due to the default of others or any other reason. On the other hand, the Gas Undertaking has a right to the support of its pipes, and if it can be proved that this support has been removed or weakened by action of another party, then that party can be held partially or wholly liable.

The majority of decisions in this case have hinged on the interpretation as to what constitutes negligence. In a recent case, an escape of gas from a broken main percolated through a gravel pit under the subway of a shop and caused an explosion in that shop. The shopkeeper successfully claimed that this accident was due to somebody's negligence. It was ascertained that certain sewer work was going on at the time, and the Gas Company claimed that this work had removed the support of the pipe, and consequently the Council or the Sewage Contractor was liable. The Council and the Sewage Contractor in turn maintained that the main in question was old and weak, and that service pipes were improperly connected, and that as far as they knew the work of excavation and filling of the trench was done in the best manner possible, and that even if the gas pipes were not old, they were not liable. During the course of the case it emerged that the Gas Company had not given any special warning to the Contractor, and had not employed any special or extra supervision when the trench was being filled in. The Company also claimed that a Contractor would resent any supervision of this nature. The Judge held that each side was equally to blame and awarded the shopkeeper damages —each side to pay one-half.

The "Kettering" Clause.

One of the most important Sections in the 1934 Act is that known as the "Kettering" Clause, viz., Section 27. It will be remembered that the Kettering Gas Company successfully appealed to Parliament to prevent a Local Authority from laying down conditions preventing the use of gas by the tenants of municipal houses. This Bill was not only fully fought in Committee but on the floor of the House. Ultimately the Kettering Company obtained its Act, not because Parliament was pro-gas, but because it recognized the right of a tenant to choose any form of light, heat, and power that he wished. There was no reason why, because he lived in a house owned by any Municipality, he should not have the same right of choice as he would if he lived in a house privately owned. In subsequent Sessions this Clause was obtained by the Gas Light and Coke Company, the South Metropolitan Gas Company, and the Commercial Gas Company. It was probably foreseen by the Board of Trade and the Parliamentary Authorities that there would be a spate of similar applications. Consequently, although the Clause was not in the Bill, it was introduced in its passage through Committee, and was given Parliamentary sanction in the Act. The Section in question is not retrospective, because the Clause opens: "It shall not be lawful after the passing of this Act." It is provided that any such provision inserted in a lease in contravention of the Section shall be void. At the same time, the lease can contain suitable provisions regulating the position in which fittings used in connection with the supply of gas are to be placed. Gas Undertakings can take civil proceedings to restrain Local Authorities from contravening the provisions, and in a final Sub-Section the expression "Local Authority" includes a Rural District Council.

(To be concluded.)

[In response to various inquiries, we are pleased to announce that, at the conclusion of the Series, we shall be able to publish Mr. Evetts' articles in book form at a price of 3s. 6d.]

Extensive Reconstruction Scheme at Smethwick.

Smethwick is to spend £31,209 on the reconstruction of vertical retorts at Rabone Lane Gas-Works. When the matter came before the Town Council, the Chairman (Alderman S. Smith) was able to give an assurance that "the Committee is alive to the fact that they must give the public gas at the very lowest price."

It was reported that at a meeting of the Gas Committee on Oct. 30, the Engineer (Mr. Ernest Hardiker) submitted a scheme for the dismantling of seven beds of vertical retorts and the construction of a bench of twenty-four 57½ in. major axis upwardly-heated vertical retorts with end producers, fittings, overhead coal storage bunkers, coal conveyor, railway receiving hopper and wagon tipper, waste-heat boiler, &c.

The recommendation which came before the Council was that the scheme be adopted and that the tender of the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., for carrying out the work, including the provision of a reinforced concrete foundation, be accepted, at the price of £31,209. It was also proposed that the Engineers be authorized to carry out sundry works, incidental to the scheme at an estimated cost of £1,500. Application will be made to the Ministry of Health for sanction to the borrowing of £20,000 for a period of 20 years towards the cost of the work.

The Science and Practice of Gas Supply*

By Arthur Coe.

Volume II.

Reviewed by

E. W. SMITH, C.B.E., D.Sc., F.I.C.

In a general review of the whole work in the "JOURNAL" of Oct. 24, the writer indicated that he would later deal with the three volumes individually. Last week he dealt with the first volume in detail, and he now discusses the second.

The second volume of Mr. Coe's treatise is devoted to the use of gas as an illuminant, the gas cooker, and the gas fire. An introductory chapter deals with the purpose and action of chimneys and flue pipes.

In the various sections of this volume, the interest of the student is aroused and stimulated by historical notes dealing with the development of the practice of illumination, heating, and cooking from the earliest times to the present day. As in the case of the first volume, the scientific basis of each branch of the subject is presented before practical details are discussed.

In connection with the design of chimneys and flues, various factors have to be taken into account, and these are all considered in detail. They include the aeromotive force developed, the effect of excess air, the effect of wind, cooling effects and their mitigation, and downdraught. It may be noted that "The sizes of flue pipes to be fitted to gas appliances are determined by the makers of the appliances and are those of the flue outlets. The size for any appliance should be such that a sufficient excess of air is made available to ventilate the appliance and to ensure sufficient oxygen for complete combustion at the maximum gas rate which can occur in practice, even under exceptional circumstances such as a 40% overload."

Flue Pipe Limits.

A useful table drawn up by Masterman and Noble and showing the economic limit to the height of flue pipes in relation to their diameter is reproduced. In another table, the pressure exerted by winds of various velocities is given, and a further table shows the equivalent wind pressures required to neutralize aeromotive forces of different magnitudes. The theory of the action of baffles and terminals is handled very well and is followed by a summary of the Standard Instructions for the Fixing of Geysers issued by the National Gas Council. Reference is also made to the use of solenoid-controlled electric fans for the ventilation of cookers and geysers under exceptional conditions, as, for example, when it is impracticable to fit a satisfactory flue pipe. Due stress is laid on the fact that when buildings are specially designed for heating by gas rather than by coal, the need for projecting chimney breasts and stacks is eliminated with a consequent reduction in the building costs, a gain in floor area, and an increase in cubical capacity. This useful chapter concludes with information on the construction of gas-fire flues for the guidance of architects and builders based on a comparatively recent brochure issued by the B.C.G.A.

In the chapters devoted to illumination, the author has been fortunate enough to secure the co-operation of leading manufacturers of lamps and fittings, and the polar curves he has been able to obtain will be of great assistance to those concerned with the planning of lighting installations, the more so since specimen layouts have also been given. The subject of illumination has been placed by the author on a practical basis, and rules for the degree of illumination required in the different rooms of houses and for various manufacturing operations are laid down. In this connection, the effect of reflection from walls and the use of reflectors is fully treated, and reference is made to the effect of glare and its avoidance. The history of gas lighting is set out in detail, and an account is presented of the development of the superheater cluster lamps nowadays so popular. Governor burners receive special attention, as does, also, the theory of their action. The effect of gas pressure on the shape of the flame, the effect of gas rate on the light output of mantles, and the regulation of burners also receive consideration. The belief may be expressed that these chapters will secure for the present volume a circulation extending beyond the Gas Industry, since much of the information will be equally valuable to the protagonists of electric lighting.

Gas Fire and Cooker Design.

The chapters devoted to gas fires and cookers are noteworthy in view of the valuable information on the principles underlying the design and operation of atmospheric burners. This is largely based on work carried out at the U.S. Bureau of Standards, but the theory of the subject has been set out at great length by the author who has evidently made a special study of it. He has also devoted considerable attention to the conditions governing the internal circulation of the hot gases in cookers, the theory of cooking and such modern developments as thermostatic control. In the appendix, complete information is given of all the standard makes and sizes of cookers. This information is particularly useful since the burner consumptions are given on a B.Th.U. basis and are therefore of much more general application than would be the case if a gas volume basis had been adopted.

In connection with gas fires, heat requirements in relation to size of room and atmospheric conditions are fully discussed, and the theory of heat loss from buildings is explained with the help of practical examples. The information is supplemented in the appendix, which includes the heat transfer coefficients of a large variety of typical wall materials of different thicknesses. Full use has been made of the valuable data published by Radiation, Ltd., on the subject of infra-red radiation and its bearing on body comfort. . A further useful feature is the inclusion of polar curves showing the relative intensity of the horizontal and vertical distribution of radiation from typical gas fires of different designs.

These chapters will be of no less importance to the manufacturers of gas fires and cookers than to the student.

In the appendix are to be found study plans which provide guidance for the courses of reading which students should pursue in connection with the I.G.E. examination in Gas Supply and the B.C.G.A. examination in the Economics of Gas Supply. These plans are sectionalized in accordance with the syllabus of each of the two examinations and will prove of the greatest help to students who wish to confine themselves to the bare requirements of the syllabus as well as to gas supply men who are about to undertake fresh duties. The fact that these plans are included should, however, not deter those having the necessary time from systematically mastering the whole of the contents.

Mr. Coe has incorporated the results of all the recent published work on the phases of gas utilization which are dealt with in this volume and has had access to and has made use of much unpublished work. The subject-matter is thus quite up-to-date. He has, however, had to fill in many gaps himself, and the theoretical considerations which he has developed and applied will not only be helpful to the student but will undoubtedly pave the way for rapid further advances in the design of gas appliances. He has shown that there is no need for the old rule-of-thumb or hit-and-miss methods, since a suitable basis now exists for developments along logical and scientific lines. This had already been realized in some quarters, but by no means universally, since there has hitherto been a lack of readily accessible information which is now made available to all as a result of the appearance of this treatise.

The high opinion of the book formed as a result of a study of the first volume has been strengthened by the second volume. The Gas Industry has long been in need of such a book, and may be expected to make wide use of it.

* Halifax 1934, The Gas College. Pp. XVI. + 551. Price, 42s. net.

International Commission on Illumination.

The triennial meeting of the International Commission on Illumination in Germany has now been fixed for the following dates: Tuesday, July 2 to 9, 1935, with the week-end following at Karlsruhe. The original date for the holding of the Commission and Congress should have been this year (the last meeting being in Great Britain in 1931), but circumstances were against it being so held. It has been decided not to hold a Congress with Papers, but a meeting of the Commission only, with reports from the various National Committees, acting as Secretariat for the particular subjects submitted to them for consideration at the last meeting of the Commission. Preceding the meeting of the Commission a meeting of the German Illuminating Engineering Society will be held in Berlin for the benefit of the members attending the Commission.

The Design of Gas-Fired Water Heaters

With Special Reference to Heat Transfer

A Paper read before the London and Southern District Junior Gas Association, Nov. 23, 1934.

By T. G. NOBLE, B.A. (Oxon.), A.M.I.H.V.E., of the Gas Light and Coke Company

Introduction.

The general recognition of the importance of the load to the Gas Industry has led to the reading of papers on various aspects of water heating. Most attention has been given to the relative merits of different types of appliance from the point of view of "saleability," effect on load factor, and ease (and hence cost) of installation and maintenance. This emphasis on what may broadly be termed "sales points," and their effect on consumer and gas undertaking, is obviously justified. Mere technical progress is of little avail to the Industry if it does not lead to increased sales, and, even more vital, steadily increasing sales. It is evident that the latter depend not only on the more obvious "sales points"—all-important as these are initially—but on a degree of technical perfection which shall ensure the maintenance, over a reasonable period, of a high all-round standard—in performance, utility, safety, economy, and appearance.

This sound technical basis alone will give us satisfied consumers, as distinct from initially-pleased customers, in ever-increasing numbers; and it is with this basis that the present paper is more particularly concerned. So many factors are involved that a complete account of all is not possible in a paper of reasonable length; nor is it necessary, since other authors have dealt with specific points in papers read before this and other technical associations.

I have therefore concentrated on the subject of heat transfer, partly because so far as I am aware there have been no previous papers in English dealing at all comprehensively with this aspect of water heating by gas, and partly because this Association still has a preponderance of "technical" over "sales" members, and I have therefore aimed at making the paper of as wide a general interest as the title allows.

It is possible that there exists a certain misapprehension as to the function of the designer in regard to heat transfer; it is certainly not to strive for thermal efficiency at all cost. In point of fact, there is little difficulty in producing a water heater of almost any desired thermal efficiency if due regard is not paid to other factors—simplicity of construction, ease of installation and maintenance, general reliability and utility, simplicity and safety of operation, cleanliness, cost, appearance, and so on—of greater importance to consumer and gas undertaking. That this is fully realized by many designers is obvious; that it is overlooked by others is equally so. It is in the hope that both may find in it a certain amount of useful information that this paper has been written.

Many of the points raised are general and could be applied to other gas-fired appliances (or, for that matter, appliances fired by other fuels), but the paper should be understood as referring only to water heating appliances (especially in the section on heat transfer) unless the contrary is specifically indicated.

Combustion—Design for Safety.

It is of paramount importance that the combustion standard of an appliance should be high, since it may affect the health, comfort, and safety of persons using the appliance. It should not be necessary for me to recapitulate to you the factors upon which the combustion primarily depends, since Mr. E. W. B. Dunning[1] has already given you an admirable account of these, and together with Mr. C. A. Masterman[2] has published the results of numerous tests on contemporary appliances, including water heaters, together with full references to other work on this subject.

There are, however, one or two general observations I should like to make. There is in this country no nationally agreed combustion standard, but all authorities, most gas undertakings, and most manufacturers would, I think, subscribe to the view that an appliance should normally work with a margin of safety. The requirement of my Company is that the CO/CO_2 ratio should not exceed 0·01 at a pressure overload of 100% (*i.e.*, gas rate overload margin of about 40%) for ungoverned appliances and 50% (*i.e.*, gas rate overload margin of about 20%) for governed appliances. The distinction is made for obvious reasons, and has encouraged the use of appliances which include either a pressure or a volume governor as an integral part of the design.

It is sometimes suggested that governed appliances do not need to have an appreciable margin on gas rate, but, until the advent of entirely non-corroding flue-ways is less remote than it appears to be at present, this view should be rejected. I am aware of no appliance the combustion standard of which improves with time*—though there are some the combustion in which deteriorates but little if correctly adjusted initially. These are generally of non-condensing or slightly condensing types, though it is conceivable that in very heavily condensing appliances the condensate would wash away any deposits or prevent their formation in vital parts of the flueways. Some "open" type geysers can be regarded as extreme examples of this phenomenon. The ideal to be borne in mind is the maintenance of a high standard of combustion over as long a period as possible; this is rarely, if ever, inconsistent with merits in other respects.

It is noteworthy that a large margin of safety on combustion necessarily implies that the appliance normally works with a low or moderate percentage of CO_2 in the flue gases—(say) 6-8%—though the converse is not true. Such an appliance has a further practical advantage in that it is less susceptible to the effects of vitiated air. This would be expected theoretically and is confirmed by experiment.[3, 4] Other things being equal, low CO_2 content implies low thermal efficiency, and it is one of the functions of the designer to overcome this defect—*i.e.*, so to design the appliance that, although working at a relatively low CO_2 percentage, it has still as high an efficiency as is consistent with the other factors mentioned in my introductory observations. Incidentally, condensation in an appliance is usually reduced, though it is not prevented, by working at a low CO_2 value. Non-condensing appliances have many merits, more especially for domestic or semi-domestic use, and have achieved a rapid popularity in this country during the past few years; but it is far from certain that condensing or even open types are doomed to a gradual extinction.

It should be clearly understood that complete combustion can be obtained with both luminous and bunsen types of burner if the rest of the apparatus is suitably designed, but the former type normally requires a combustion chamber and air inlets of greater capacity. Where space-saving or intense local heating is vital, the bunsen burner has a distinct advantage, but the merits of the luminous burner in other respects, notably simplicity, cheapness, ease of thermostatic or other automatic control, and freedom from lighting back (though not all bunsen burners light back[5, 6]), frequently more than offset these advantages.

I do not propose to say much more about burner design. Your President[6] recently summarized some important, if not absolutely conclusive, work done in America, and I have given further references[7, 8] in the bibliography at the end of this paper. Luminous burners of various types have once more become popular and are almost exclusively employed for domestic water heating appliances.† For completeness I should mention that various forms of semi-bunsen burner are now available, though I have not so far found any special use for them. Larger special burners, of the types designed for the conversion to gas-firing of central heating and other large units originally burning alternative fuels, are more numerous in the U.S.A. than in this country. The report of the University of Purdue[9, 10] indicates that on the whole they differ more in cost and appearance than in efficacy, with which view such experience as I have had is in agreement.

* Beyond a few minutes.

† The wash-boiler is a notable exception.

Ventilation.

Draught.

The natural draught and resistance control the total air supply, and hence to a large extent the combustion and heat transfer, in the majority of gas-fired appliances, though some part may be supplied by injector action. The ventilation of an appliance, as normally understood—*i.e.*, removal of the products of combustion from the appliance by means of a flue—has been discussed by various authors.[11 15] The same laws govern the self-ventilation of appliances, as the flow of air and combustion products through the appliances may be called, but the difficulties of applying theory to practice are greater and sometimes insuperable owing to the usually irregular variation of the flue gas temperature over a very wide range (from something of the order of 3,500° F. down to 300° F. or less).

Resistance.

The resistance of the appliance to the flow of air or flue gas is also difficult to estimate except for very simple constructions. The total resistance is the sum of the partial resistances—at the air inlet, burner, combustion space, flueways, flue exit (including baffler)—all of which must be evaluated. Just as the resistance of fittings—elbows, tees, bends, &c.—can be calculated in terms of the velocity and density of the fluid flowing, and a resistance constant k,* so the resistance of any flueway, under any specified flow condition, can be calculated *once its resistance under known conditions has been measured—i.e.*, its k has been determined. The simpler the design of the flue-ways of an appliance, the easier it will be to estimate the resistance from published values of k (which cannot yet be calculated from first principles) for various shapes—restrictions, changes of direction, &c. Much more work is needed on this subject before the accurate calculation of the air flow through an appliance can become generally possible, but the fullest use of existing data will at least prevent the more obvious errors.

The total resistance constant

$$K = k_1 + k_2 + k_3 + \ldots\ldots \text{ \&c.,}$$

where k_1, k_2, k_3, &c., are partial resistance constants; it is of importance to determine which of the partial resistance is greatest, since this exerts a controlling influence, and time spent in attempting to reduce the lesser resistances is virtually wasted. An example of the type of calculation involved is given by Dr. Geck.[16]

Bafflers or Draught Diverters.

The need to fit a good baffler on any appliance which is connected by a flue pipe to some point outside the room in which it is fixed is now fairly generally recognized. I would, however, stress the desirability of designing the baffler as an integral part of the appliance; this is too often ignored, with sad results both technically and æsthetically. There is no difficulty in designing a baffler which is safe—although even this most elementary requirement is not met by all current designs—but there is often great difficulty in meeting the various other requirements of a good baffler. The finer points of baffler design are, however, too numerous and too complex to be adequately discussed in this paper, and I can only refer you to such publications as Dr. Schumacher's book[12] and the A.G.A.[17] and D.V.G.W.[18] performance requirements for bafflers, with a warning that the requirements are not always strictly applicable to conditions in this country.

Heat Transfer—Design for Compactness.

General.

The literature on heat transfer is so vast and contains so much conflicting or apparently conflicting evidence that in searching for the vital parts one is inclined to give up in despair. In recent years the task has been lightened by the publication of such books as those of Schack[19] in Germany (with a more recent American Translation[20]), McAdams[21] in America, and Fishenden and Saunders[22] in this country. The following notes on the application of the general laws to the design of gas-fired water heaters owe much to the authorities mentioned and to the authors of the various original papers consulted.

Heat may be transferred by the three familiar mechanisms of conduction, convection, radiation, of which the first two require a material medium and are thus fundamentally different from the third. The importance in technical processes of heat transmission by radiation from solids has long been realized, but it is only since the pioneer work of Schack[23] that the part played by the infra-red radiation of certain gases, notably CO_2 and H_2O vapour (if I may be allowed to call water vapour a "gas") has been appreciated and begun to have an effect on design. As will be appreciated later, the conventional German geyser construction adopted for various good reasons long before Schack's work was published can be justified theoretically by the application of his ideas—an interesting and by no means isolated example of practice preceding theory, which may comfort those who regard theory with suspicion!

Conduction.

All heat transfer in closed type water heaters ultimately has to take place by conduction through a solid wall, usually, though not invariably, of metal. It is the simplest process to understand and, as will be apparent later, the least important in gas-fired water heaters in the sense that it is rarely the controlling factor in heat transmission therein. (It is, of course, important when surface heat losses—*e.g.*, from storage heater or pipes[24]—are being considered and in other types of appliance, such as gas-fired furnaces.[25])

The thermal conductivity k of a substance may be defined by the well-known equation

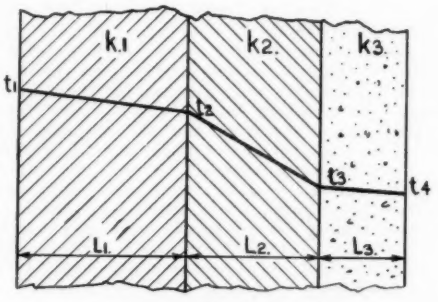
$$Q = k\frac{A(t_2 - t_1)}{L} \quad \ldots\ldots\ldots\ldots \quad (1)$$

The solid flue wall of a water heater may be composite; for such a wall, where the individual thermal conductivities and thicknesses of the various layers are known, the heat flow is given by

$$Q = \frac{A(t_1 - t_n)}{\frac{L_1}{k_1} + \frac{L_2}{k_2} + \ldots\ldots \frac{L_n}{k_n}} \quad \ldots\ldots\ldots \quad (2)$$

where t_1 = temp. of outside of first layer.
t_n = ...nth layer.
L's are thicknesses.
k's are individual conductivities.

Equations (1) and (3) are strictly valid only for a wall of uniform cross-section tranverse to the uniform heat flow, having no temperature coefficient of conductivity, and no lateral heat loss. Similar but rather less simple equations can be derived for other conditions and shapes more commonly met in practice (*cf.* [20] pp. 2-27). From the preceding equations the temperature drop across various layers may be calculated—



TEMPERATURE DROP IN COMPOSITE WALL

FIG. 1.

e.g., in Fig. 1, $t_2 = t_1 - \frac{QL_1}{k_1 A}$

or $t_1 - t_2 = \frac{QL_1}{k_1 A} \quad \ldots\ldots\ldots \quad (3)$

From this equation it is seen that for a given area A of surface, a given thickness L, and a given heat flow Q, the temperature difference is inversely proportional to the thermal conductivity of the material of the wall—*i.e.*, the replacement of a wall by one of lower conductivity, heat flow, thickness, &c., being kept constant, results in an increased temperature difference.

The magnitude of this temperature difference across various thicknesses of three common materials at rates of heat flow of orders found in gas appliances is shown in Table I.

It will be seen that the temperature difference is small the normal thicknesses of metal: notice also that the temperatures given in columns 5 and 6 are well below 140° for the metals, but above it for asbestos cement of the same thickness. The temperature of the water side of the wall

* Resistance = $\frac{kU^2G_2}{2g}$ where k is resistance constant characteristic of the fitting, U = vel. in. ft./sec., G_2 = density in lbs./c.ft. Ref. [14].

may be taken as practically equal to that of the water: this is clearly the minimum possible value, but there is ample evidence that the actual wall temperature on the water side is not in practice much higher.

TABLE I.

Material.	Thickness.	Heat Flow in B.Th.U. Sq. Ft./ Hr.	$t_1 - t_2$. ° F.	Temp. of Flue Gas Side assuming Water Side to be at—		
				50° F.	100° F.	150° F.
Copper . . . $k^* = 250$ . .	22 S.W.G. = ·028 in.	1,000	·009	50·009	100·009	150·009
		5,000	·045	50·045	100·045	150·045
		10,000	·09	50·09	100·09	100·09
	¼ in.	1,000	0·08	50·08	100·08	150·08
		5,000	0·4	50·4	100·4	150·4
		10,000	0·8	50·8	100·8	150·8
Cast iron . . . $k^* = 25$ . .	⅛ in.	1,000	0·4	50·4	100·4	150·4
		5,000	2·0	52	102	152
		10,000	4·0	54	104	154
	¼ in.	1,000	0·8	50·8	100·8	150·8
		5,000	4·0	54	104	154
		10,000	8·0	58	108	158
Asbestos cement . . . $k = c.$ 0·1 . .	¼ in.	1,000	200	250	300	350
		5,000	1,000	1,050	1,100	1,150
		10,000	2,000	2 050	2,100	2,150

* B.Th.U./sq. ft./hr./ F./ft. thickness.

Application to Non-Condensing Appliances.

These facts find practical expression in some types of non-condensing appliance where the wall temperature on the flue gas side of a heating surface is raised above condensation temperature (about 110°-140° F.) by the use of a wall of relatively poor conductivity in place of a simple metal wall. Sometimes in order to keep the thermal efficiency of the appliance at its original value—*i.e.*, avoid a reduced total heat transfer—it is necessary to increase the actual area of heating surface when metal is replaced by an insulator, but, as explained later, this is by no means always necessary, and there is at least one popular domestic appliance on sale to-day in which such a change has been made without increase in heating surface or appreciable loss in efficiency.

Conductance.

In dealing with heat transmission in appliances one has frequently to consider thin stagnant or relatively stagnant films of flue gas and water, of unknown thickness, separated by a solid wall, and it is convenient to use another term, the conductance, h, which may be defined as the number of heat units passing through a simple heat transmitting medium of unit cross-sectional area, in unit time, and with unit temperature difference; it applies to a definite though not always specifiable thickness—

$$i.e., h = \frac{k}{L}$$

Overall Conductance.

The overall conductance H_o of a composite solid wall depends on the individual conductances h_1, h_2, &c., thus

$$\frac{1}{H_o} = \frac{1}{h_1} + \frac{1}{h_2} + \frac{1}{h_3} \ldots\ldots \text{&c.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$\text{or } H_o = \frac{1}{\frac{1}{h_1} + \frac{1}{h_2} + \frac{1}{h_3}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4a)$$

The overall conductance is thus necessarily less than the smallest of the individual conductances across the layers through which the total heat flow occurs. This is a point of the greatest practical importance and will be enlarged on subsequently.

The composite wall in a gas-fired water heater consists, in the simplest case, of the triple system—namely

still liquid film—simple solid wall—still gas film

for which the overall conductance may be defined by the equation

$$Q = AH_o (t_g - t_w) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where H_o is the overall conductance in B.Th.U./sq.ft./hr./°F.

t_g is the temperature of the hot gas.

t_w is the temperature of the water.

(The equation is adapted to suit gas appliances, from the general form.)

The overall conductance is determined by the thermal conductivity and thickness of the wall and the *surface conductances* h_g and h_w* at each of the wall surfaces, as shown by the equation

$$H_o = \frac{1}{\frac{1}{h_g} + \frac{1}{h_w} + \frac{L}{k}} \text{ B.Th.U./sq.ft./hr./°F.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

* The suffixes g, w, refer to surfaces in contact with gas and water respectively.

Surface Conductance.

The surface conductance (or "film coefficient") h is an extremely important concept, defined as the quantity of heat transferred across 1 sq. ft. of solid surface per hour per ° F. difference in temperature between the solid wall and the fluid (gas or liquid) with which it is in contact; or expressed as an equation

$$Q = h (t_{fluid} - t_{wall}) A \text{ B.Th.U./hour} \quad . \quad . \quad . \quad . \quad (7)$$

Although ultimately, in a sense, a measure of conductivity (of a film of fluid) the surface conductance involves fluid flow (*i.e.*, convection) and is not expressible by simple laws. It is further discussed under "convection." The similarity of equations 6 and 4*a* will be noted. They are, indeed, identical in form, the difference being that whereas 4*a* was applied to a composite (triple) solid wall, 6 is expressed in a form more applicable to most water heaters.

Effect of Individual Conductances on Heat Transfer.

It has been indicated already that the overall conductance of a system is necessarily less than the *smallest* of the individual conductances. An electrical analogy may be helpful. The reciprocal $\frac{1}{h}$ of a conductance may be regarded as a measure of the resistance (R_h) of a wall or film to heat flow. From equation 4, by substitution

$$R_h = R_{h1} + R_{h2} + R_{h3} + \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{&c.}$$

Heat flow through a composite wall is thus analogous to the flow of a current through several electrical resistances *in series*—the total resistance being necessarily greater than any of the individual resistances. If any one of the resistances is much greater than any of the others, a small change in one of the latter has little effect on the total resistance, which cannot be reduced appreciably even by total removal of one of the small resistances. A *large* electrical resistance in this analogy is the equivalent of a *small* (heat) conductance; if one of the individual conductances is much smaller than any of the others it will be the controlling factor, and even a very large increase in the other conductances will leave the overall conductance practically unaffected. To give an even simpler analogy—one needs only one waterproof layer to keep out the rain!

In the system

"Still liquid film—solid wall—still gas film,"

the controlling factor is h_g—the surface conductance on the gas side, which is found to be of the order of 10. The conductance of a $\frac{1}{10}$-in. iron wall is of the order of 3,000, and the surface conductance on the water side is of the order of 1,000 (all expressed in B.Th.U./sq. ft./hr./° F.).

The overall conductance is thus of the order of

$$H_o = \frac{1}{\frac{1}{10} + \frac{1}{3{,}000} + \frac{1}{1{,}000}}$$

$$= \frac{1}{\frac{300 + 1 + 3}{3{,}000}} = \frac{1 \times 3{,}000}{304} = \text{c. } 9{\cdot}9 \text{ B.Th.U /sq.ft./hr./° F.}$$

i.e., nearly the same as the surface conductance on the gas side.

Table II. shows some typical conductances (calculated for thicknesses of $\frac{1}{10}$ in. and $\frac{1}{100}$ in.).

TABLE II.

Material.	K.*	h † $\frac{1}{10}$".	h † $\frac{1}{100}$".
Iron (cast)	25	3,000	30,000
Copper	250	30 000	300,000
Scale	6	720	7,200
Liquid water‡	(very variable) 0·6	72	720
CO_2‡	0·017	2·0	20·0
H_2O‡ vapour	0·017	2·0	20·0
Air‡	0·024	2·8	28·0

* B.Th.U./sq.ft./hr./°F./ft.

† B.Th.U./sq.ft./hr./°F.

‡ Assuming still layer. These values are not *surface* conductances.

Practical Implications of Surface Conductance.

It is clear that for any effective increase in heat transmission to occur the surface conductance on the flue gas side must be appreciably increased. It is idle to attempt to increase heat transmission effectively by increasing the conductance of the metal wall—*e.g.*, by using thinner metal or metal of higher thermal conductivity—or by increasing the conductance on the water side by adding fins to that side or by controlling the flow of water through the appliance. All these methods are suggested from time

to time as means of increasing the efficiency of water heaters or as explaining the high efficiency of particular appliances and in no cases that I am aware of have the suggestions any sound experimental or theoretical justification.

It will have been noticed that, while talking of conduction, we have been compelled to introduce reference to fluid films and to use the term "surface conductance" without being very precise. In the next section an attempt is made to give more precision to these ideas.

Convection.

The mathematics of heat transfer by convection is extremely complicated, and only in a few simple cases has an adequate analysis of fluid motion, temperature distribution, and heat transfer been possible. This is not surprising in view of the dependence of convection heat transfer on velocity, density, conductivity, specific heat, and viscosity of the fluid, and on the size, shape, and temperature of the body gaining or losing heat. Numerous empirical formulæ have been proposed from time to time, which have been correlated by Fishenden and Saunders[22] and others[21] on the basis of the principle of similarity.

It is necessary to distinguish between natural and forced convection. The distinction usually made is that in the former the fluid motion is due solely to the effect of the difference in density between the hotter and colder parts of the fluid, while in forced convection the fluid motion is caused by forces not connected with the temperature of the fluid—*e.g.*, by externally imposed pressure differences. This distinction does not appear to me to be quite adequate, and I suggest that it is better to distinguish two types of natural convection—

(*a*) free natural convection—*e.g.*, convection at the surface of a freely exposed warm vertical wall in otherwise still air. The heat loss for such a surface is proportional to the $\frac{5}{4}$th power of the temperature difference between the wall surface and the surrounding fluid;

(*b*) "constrained natural convection," as in most gas appliances. The conditions are very similar to those ruling when the convection is forced, the motive power being the natural draught in the appliance. The formulæ commonly applied to forced convection are here more appropriate.

It is necessary further to distinguish between streamline and turbulent conditions, but a few simple calculations show that in gas appliances streamline flow, although it may be established, is not stable.

Relation of Fluid Flow to Heat Transfer.

It was early realized that heat transfer from fluids and the fluid motion are intimately related, and much time has been spent in elucidating the relationship, not altogether successfully. Thus "there is a close analogy between the transfer of heat by *conduction* and the transfer of *momentum* by viscous friction within a gas, for it is the continual intermingling of the gas molecules, which have much greater freedom of relative movement than those of a solid or liquid, which tends to equalize the distribution of heat or of momentum throughout the gas."[22]

With streamline flow there is no appreciable radial motion of the fluid particles, and hence heat transfer from the body of the fluid to the surrounding walls would be expected to be mainly by conduction. It would, therefore, be supposed that with such flow the surface conductance would be directly proportional to the conductivity of the fluid and inversely proportional to the diameter D, but *independent* of the velocity of fluid flow; these expectations are amply confirmed by experiment. The values of the surface conductances with this type of flow will obviously be much lower than when, as is fortunately general in gas appliances, the flow is turbulent, and the heat transfer takes place mainly by convection, being greater the greater the mean velocity component perpendicular to the wall. It will be at a maximum when the whole stream of fluid is directed against the heating surface. Reiher[26] has found, for example, a sevenfold increase in surface conductance for this condition as compared with turbulent flow parallel to the surface. This is the theoretical justification for certain types of flue baffle (*cf.* B.P. No. 361,329) and it is a partial explanation of the high rates of transmission obtainable when flame contact is used.

It has been shown by Reynolds, Prandtl,[27] and others that heat transfer to a wall by convection is intimately related to the skin friction. The study of this relationship has been one of the more fruitful means of increasing our knowledge of heat transfer. The correlation is by no means perfect for all cases, but the practical advantage that skin friction is generally easier to measure than surface conductance has led many investigators to prefer this treatment to the alternative method of approach used by Nusselt[28]—viz., the principle of similarity. A third method due to Thoma,[29] and subsequently used by Lohrisch,[30] has been to relate heat transfer to diffusion.

Surface Film.

One conclusion of vital importance has been generally accepted—viz., that *wherever a fluid stream is in contact with a solid boundary there is a limiting film of fluid which is more or less stagnant and moves in streamline flow if at all.* Heat passing from or to the solid surface must be passed through this film by conduction, regardless of convection in the body of the fluid, even though the motion thereof be turbulent. One is led, therefore, to regard turbulent flow as being to some extent as represented in fig. 2 (based on McAdams[21]).

At the wall (OO) the velocity is zero and very near it (OA) the flow is streamline. Then follows a transition zone AB, beyond which the action is entirely turbulent. The maximum disturbance or breaking down of this film should be the primary object in the design of all convection heat transfer appliances. The direct experimental evidence for the existence of this film is of very great interest, but I have no time to give it now and can only refer you to some relevant papers.[29 31–37] The film may be partly broken down—*i.e.*, reduced in thickness—by any means which increases turbulence—*e.g.*, increase in velocity, roughening of surface (within limits), use of baffles, &c. In one set of experiments, for example, Van der Hegge Zijnen[35] showed the thickness of such a gas film to be decreased from 0·087 to 0·018 cm. by an increase in air velocity from 13·1 to 78·7 ft./sec.* In terms of heat transfer this would mean a considerable increase in surface conductance, since *it is owing to the existence of this poorly conducting stagnant film that the surface conductance on the gas side is so low.* This is the physical explanation of the controlling effect of h_g† (the gas surface conductance) on the total heat transmission.

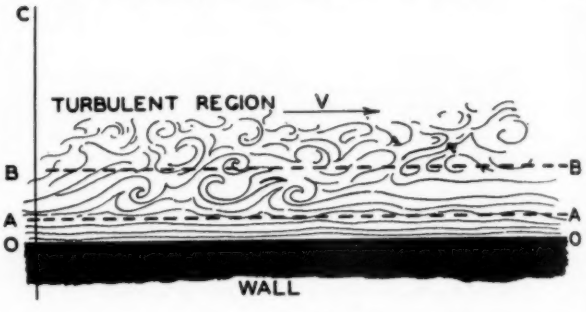


FIG. 2.

Theoretical and Practical Conclusions.

I must apologize for a somewhat lengthy theoretical discourse. I hope it is not without practical implications. In the first place, a better understanding of the mechanism of heat transfer is an important step towards practical results, incidentally disposing of some common fallacies. Secondly, it indicates the lines along which some of the more important equations suggested have been developed; and, thirdly, it should assist in the selection of suitable equations for use in practice and give a better idea of the significance and relative importance of certain factors in the design of new and old appliances. It may be as well to state at once that there is no final generally accepted equation; but from the mass of published proposals the authors to whom I have most referred[19 22] select certain equations as the best for turbulent flow in pipes and give simplified versions applicable to the practical conditions we are considering. These selected equations differ appreciably but lead to the following general conclusions:—

(1) The surface conductance hg is proportional to the nth power of the velocity and density of the gases, where n is about 0·75-0·8.

(2) It is independent of temperature (except in so far as this affects density). This conclusion is less generally accepted than the preceding and must be regarded as provisional. Nusselt's formula, for example, predicts a variation not confirmed by the experiments of Schulze[39] and others.

(3) It is inversely proportional to the nth power of the diameter (or equivalent dimension for non-circular shapes) where n is probably about 0·25. Higher

* Note that these velocities are of a higher order than is normally found in gas appliances.

† This effect is noticeable in other connections: it explains why, from the point of view of heat loss only, asbestos cement flue is not greatly superior to metal, though it has other advantages (*cf.* [28, 12, 14]).

powers (up to 0·4) have been obtained by Schulze[39] and lower (down to 0·16) by Rietschel,[40] whilst the principle of similarity predicts a value of 0·2.

The above conclusions apply to technical "smooth" flueways, for which we have further, in cost cases,*

(4) The *overall conductance* (in constrained convection) is proportional to the temperature difference between the hot gases and the water. This temperature difference calls for care in definition (*cf.* [26] p. 115), and it is frequently difficult to measure. The determination of true gas temperature alone is not always easy (*cf.* Hottel[41]).

(5) It is further inversely proportional to the *m*th power of the diameter D where *m* is about 0·25.

(6) It is directly proportional to $V^{0\cdot75\text{-}0\cdot8}$ where V = linear velocity.

(7) It is directly proportional to the 0·75th-0·8th power of the mass, G, of gases flowing in unit time. This follows from its dependence on both V and ρ (the density) to the same power and hence on their product $V \rho A$, the mass velocity. For a given mass velocity it is inversely proportional to $D^{1\cdot75}$.

There is no contradiction in the two statements (5) and (7) of the effect of the diameter.

Thus, H (the overall conductance)

$$\propto \frac{G^{0\cdot75}}{D^{1\cdot75}}$$

$$\propto \frac{(V \rho A)^{0\cdot7}}{D^{1\cdot75}}$$

where A = area of cross section

or for a given density

$$\frac{V^{0\cdot75}(D^2)^{0\cdot75}}{D^{1\cdot75}}$$

$$\frac{V^{0\cdot75}D^{1\cdot5}}{D^{1\cdot75}} = \frac{V^{0\cdot75}}{D^{0\cdot25}}$$

The mass velocity, being a constant across any section of an appliance, is more convenient for practical use than the linear velocity.

(To be continued.)

*Strictly equations 4–7 apply only when h_g is the controlling factor: as explained, this is usually true in gas appliances but *cf.* p. 22 in thick layers of scale, and p. 35 in condensing conditions.

Essential Factors in the Promotion of Gas Sales*

By Sir FRANCIS GOODENOUGH, C.B.E.

The Campaign Among the Doctors.

In these schemes of inspection and maintenance, particular attention is paid to influential classes of the community, such as doctors, architects, builders, consulting engineers, and public health workers. There is a sound historical reason for this discrimination.

Twenty-five years ago, there was in England a widespread prejudice against gas fires, particularly on the part of medical men who had personal experience of the use of badly constructed or badly fixed or badly maintained fires. It was no uncommon thing for a doctor to order a gas fire out of a patient's bedroom. The damaging effects were obvious. We therefore began a vigorous campaign to induce doctors to give modern gas fires a fair and unbiassed trial on their real merits.

The first step was to send letters to every doctor in the area, emphasizing the hygienic value of gas heating and offering to fix a gas fire on trial, free of fixing charge, in any room chosen by the doctor.

This brought in a fair number of replies, mainly of a hostile or sarcastic character. Under these unpromising conditions (I was then actively at work for the Gas Light and Coke Company) we began a keen campaign in the Harley Street district of London, a district where you could hardly throw a stone without hitting a medical specialist. The results disclosed in the houses of many who used gas fires were appalling. The only reason for using them was that of convenience, for in point of appearance, economy and hygiene they were travesties of the real thing.

Needless to say, we stuck to the job, using only specially qualified men, and employing a special filing system for the reply-postcards which accompanied our letters. Within four years the percentage of doctors using gas fires in the district had increased from 25 to 62. In one instance a famous doctor who had recently turned thirteen gas fires out of a patient's house was himself persuaded to have ten fires installed in his own house. The letter which he wrote on that occasion is one of the most valuable testimonials we have ever had.

To-day the Harley Street district consumes more gas than any other area of equal size in the British Isles. More than three-quarters of the doctors all over the country use gas fires, and the same figure applies to hospitals and nursing homes. The Company will certainly not relax their efforts until the only doctors not using gas for heating are like the Scottish doctor who informed us that though gas fires were all right, he considered that we were criminal in encouraging people to use fires of any sort in their bedrooms; for his part, he never needed a fire at all, and everyone ought to be as hardy.

No single factor has influenced the sale of gas appliances more than the weight of medical opinion which has thus been turned in our favour. In Britain, as in other countries, the doctor exercises a very real power in most households; and the fact that he himself is a satisfied user of gas is one of the strongest recommendations we could have.

In the early days of our campaign, before the hygienic qualities of the gas fire were fully recognized, an American who was leasing a West-end hotel said that he would consider using gas fires if he could be taken to a doctor of standing who was a gas consumer. Within an hour the gas salesmen were taking him round in a taxi to three distinguished specialists, who were thus the instruments of giving us an immediate order for thirty fires. They were busy men, and they did it out of pure goodwill towards us. That is a concrete instance of the value of our campaign. It would be quite impossible to estimate the total value of all the goodwill it has generated.

Our experience among the doctors led us to extend the same methods to architects, builders, estate agents, public health workers, and so on. Each satisfied consumer of this kind is an unpaid salesman for gas. It should be added that for this kind of work a very good type of representative is needed; we believe that a specialist is needed for dealing with specialists.

Showrooms.

Apart from outside sales activities, there have been strong efforts to get the gas showrooms regarded in the light of popular stores, so that casual customers may be tempted in to look at the latest appliances. Practically every undertaking has at least one showroom; the larger undertakings, on the average, have one showroom for each 1,000 million c.ft. of gas sold. In recent years the design and arrangement of these showrooms have been greatly improved.

In the first place, showroom windows have been reconstructed to admit of the most modern type of display. Many undertakings maintain display experts of their own; others share the services of one first-class man. In addition, special or standardized displays are obtained both from the British Commercial Gas Association, which runs a display studio for the service of its members, and from the makers of appliances.

Another improvement has been the addition of demonstration theatres, where cookery demonstrations and lectures are given regularly. Very many undertakings have their own staff of women lecturers and demonstrators, who must hold the certificate of a recognized course in domestic science. Besides the ordinary demonstrations for housewives, there are in some cases cookery classes for husbands, bachelors, and business girls.

A showroom feature which is becoming increasingly common is the model kitchen which may be used to show consumers how their individual kitchen-planning problems can be solved by gas service. Travelling showrooms are widely used for propaganda among consumers in outlying

* A paper presented to the Colonial Gas Association Centenary Conference in Melbourne, 1934—continued from p. 627 of last week's issue.

areas. In some country towns the undertakings hire stalls at the weekly markets, where good business is done.

Radiating from the showrooms are numerous activities designed primarily to keep the goodwill of consumers. After the purchase of a cooker, for instance, a woman demonstrator visits the house to give the housewife every possible help in becoming expert in its use.

Co-operation with Builders.

Again, model all-gas houses are opened to the public for inspection on new building estates. Sometimes this is done in conjunction with a local newspaper. At other times it is done jointly with the builder of the housing estate; in this case the builder has to erect the house for his own publicity purposes, but the gas undertaking fits it throughout with gas appliances and arranges to floodlight the house and posters.

This can only be done when the builder has been convinced that houses can more easily be sold when gas is installed. Prospective house purchasers, therefore, are interviewed beforehand by the gas salesman and acquainted with the benefits of gas appliances and the convenience and economy obtainable in excess of that given by electricity. Service is given to the builder in the way of advertising, by submitting layouts for poster work and initiating a builder's advertising brochure in which the gas undertaking pays for space. At each " show " house a representative and a cookery demonstrator are in attendance.

Some undertakings link up with special weeks at local department stores and arrange cookery demonstrations in the store premises.

Similarly, the gas undertakings regularly take part, by means of lectures and demonstrations, in local health weeks, welfare weeks, baby weeks, and so on. The lectures, though general in scope and delivered by well-known people from outside the district, touch incidentally on the hygienic and economical advantages of gas appliances.

Women members of the sales staff are required to interest themselves in the local activities of national societies and associations, such as women's institutes and the townswomen's guild. In addition, in several districts Women's Gas Associations have been established to interest consumers in the national aspects of the Gas Industry's work. The members of these Associations pay a small annual subscription and attend monthly meetings, where a visiting lecturer delivers a talk which is followed by a discussion. There is a social atmosphere at these meetings and they have much goodwill value. It is probable that they will soon be linked up on a larger scale.

More women are employed on the selling side than ever before. In addition to specialist cookery demonstrators, there are women receptionists, showroom managers and saleswomen, many of whom have taken the course in Domestic Gas Salesmanship. The importance of having at least one educated woman of some social standing to meet customers in the showrooms and outside them is very widely recognized. Some undertakings have gone much further; they employ women canvassers and women meter-readers, with good results.

In many districts it is a woman inspector who is responsible for seeing that the gas apparatus at Domestic Science Centres is up-to-date and efficient. This is a most important service, for the attitude of future consumers will depend largely on their experience of gas during their training period. The cooking plant for these centres is in many cases provided free, and free maintenance is practically universal. The undertakings also present to teachers of Domestic Science an authoritative book published by the B.C.G.A. on the domestic uses of gas.

Industrial Centres.

The value of all these methods has been proved in the promotion of domestic gas sales. The question of industrial sales offers other problems. In Britain about one-fifth of the total sales of gas goes to industrialists. In Sheffield about 50% of all the gas sold is for industrial purposes, and in Birmingham the percentage is about 30. With appropriate scales of charges there is a great future for gas in Britain for industrial purposes, and it may be useful to touch on our national organization for industrial sales.

An important qualification of the industrial salesman is a profound practical knowledge of other industries in their relation to the Gas Industry—*i.e.*, to the use of fuel for their special processes; and thus it has occasionally been expedient to utilize men trained in other branches of engineering as industrial gas salesmen. Most of the salesmen, however, receive their training in the large-scale workshops and laboratories which are maintained by the bigger undertakings in manufacturing areas.

Manufacturers are invited to bring their own particular problems of industrial heating to be solved in these workshops. The most notable are at London, Birmingham, Newcastle, and Cardiff. In recent months it has become obvious that great advantages would accrue if the work done at these and other industrial laboratories could be co-ordinated for the benefit of all undertakings, large and small. With this object in view, the Industry has been organized in districts, with a large undertaking in each acting as an Industrial Centre to which the smaller undertakings, who pay a small annual subscription, may take their customers for advice and practical assistance in the demonstration workshops. There are now ten such centres in operation. They periodically circulate to their district members data obtained on the jobs with which they have been dealing. The data are sent also to a central bureau, which in turn disseminates to all districts such information as it considers useful. There is thus in being a national organization for industrial problems.

Advertising and Sales.

It is by a natural transition that I pass to our national organization for publicity—the British Commercial Gas Association. It is now becoming generally recognized that it is as important to advertise the services which public utilities can render to the community, as it is to advertise the goods of firms which have no monopoly rights of supply. In fact, it is even more important; because the public utility which is bent on extending its service to the community must first batter down the public prejudice against officialism in all its forms. Advertising can do much to remove the prejudice while it is educating the public to take full advantage of all the benefits which the Gas Industry can give. For that reason, advertising should be an integral part of gas sales policy.

The British Commercial Gas Association, founded twenty-three years ago for co-operative advertising and selling, represents in its membership 96% of the total gas sold. Its annual income is between £70,000 and £80,000. This is derived from subscriptions based on the sales of gas. Its first function was Press advertising, but it has since extended its field of operation. Since the foundation of the B.C.G.A., sales of gas in Britain have increased by 50% during a period when the competition of electricity has grown steadily more fierce. A fixed proportion of the revenue is used in newspapers with a district circulation. Most of the remainder is used in morning newspapers and magazines with a national circulation. Those undertakings profit most who back up B.C.G.A. advertising by taking space in their own local Press, as very many do.

Recently our Press advertising has been concentrated on the popularization of the " Therm " method of charge, which in this country has displaced the method of charging on the basis of volume. With this end in view a (frankly invented) figure called " Mr. Therm " has been used. His intention is to humanize the Gas Industry in the eyes of the public. In this light he resembles other symbolic figures like " Johnny Walker " and " Micky Mouse."

It must be stressed that the principal function of national advertising is not so much to obtain orders directly as to create a favourable atmosphere for gas, a favourable background for local, individual sales efforts. Widespread publicity goes far to weaken " customer-resistance," whether this is met in the form of objection to the cost of appliances, the cost of gas as a fuel, or in the form of prejudice against gas by reason of electrical bias.

Special advertising in trade and professional journals is addressed to industrialists, doctors, teachers, councillors, architects, and so on.

The B.C.G.A. is responsible also for the production of large quantities of sales literature to be distributed by its members. Because of the bulk orders it is able to give, the cost of these productions is much lower than could be obtained by an individual undertaking seeking quotations for the same job. A recent booklet used as a follow-up to an advertising campaign ran to half a million copies sold.

The Association produces also a monthly publication (*A Thousand and One Uses for Gas*), each issue of which deals with some special use of gas. Some issues are sold in quantities which total 100,000; others are of a more technical nature and have a more restricted but none the less useful circulation.

Every quarter a woman's magazine (*The Flambeau*) is issued. This is a propaganda journal in which the publicity pill is carefully gilded. The sales are steadily rising.

A third periodical is the monthly *Bulletin*, or house organ, which is intended to be a running commentary on the sales methods and ideas of members, many of whom contribute special articles.

In addition to all this, the Association maintains a large range of services for members. These include a copy, layout, and block department for members' own advertisements in local media; an editorial service for the supply of articles; a poster and display service; and an experienced lecture staff. Among new activities may be mentioned an investigation into the possibilities of publicity films, and a Home Service section which will co-ordinate the activities of women engaged in the Industry.

Conservation of Heat Energy in Relation to Horizontal Retort Practice

Read before the North of England Association of Gas Managers (Auxiliary Section) at their Half-Yearly Meeting at Newcastle, Nov. 24, 1934

By W. OLIVER KIRKWOOD, Chief Chemist of the Sunderland Gas Company

During the past twenty years a great deal of thought and conscientious study has been devoted to the conserving of energy in its various forms, and especially is this so in the case of heat energy. One prominent branch of the conservation of heat energy is the economic generation of steam in waste-heat boilers where the sensible heat present in the flue gases leaving retort settings is utilized. On many works the supply of steam for process work, &c., has been augmented by the generation of steam from this source of surplus heat energy.

Although this paper is primarily a theoretical treatise on the utilization of heat from the combustion of coke in the horizontal regenerator setting and the recovery of surplus heat, a proportion of it has been devoted to the working of a waste-heat boiler and subsidiary plant, with the hope that it will prove of considerable interest to the members of the Association who may be called upon to investigate both theoretical and practical problems connected with the economic utilization of heat energy. At the same time it may promote serious thought not only upon the generation of steam from surplus heat but in other branches of heat treatment.

Owing to the length of the paper it is not practicable to give in detail all the calculations which are necessary to obtain the conclusions reported. It follows therefore that only necessary figures are given in order that a clear conception of how heat produced on the combustion of coke is utilized during the working of the setting and the subsequent recovery of surplus heat in the waste-heat boiler plant.

Section 1 deals with theoretical considerations of the heating of a setting where the producer is fed with a coke made from a Durham gas coal. From the theoretical determinations of the section it is found that, by recovery of the sensible heat in the flue gases under the conditions stated, it is possible to recover 21·9% of the total heat value of the original coke fed into the producer. An appendix to this section shows the effect of excess secondary air upon the efficient working of the setting and also its effect upon the heat value of the producer gas entering the combustion chamber when the draught conditions remain unaltered. The conclusions of this appendix also emphasize the possible adverse effect of free oxygen present in the products of combustion leaving the combustion chamber upon the thermal yield of coal gas and the quality of the residuals if negative pressure conditions exist within the retorts under ordinary working conditions.

In section 2 results are given of a works test of a fire-tube waste-heat boiler utilizing the sensible heat present in the flue gases leaving a bench of horizontal regenerator settings.

In section 3 the comparative costs of steam raising are summarized, and the results indicate very definitely the low cost at which steam can be generated from surplus heat in waste-heat boilers as compared with hand-fired Lancashire boilers using coke breeze under forced draught. In this section also suggestions are given for the utilization of surplus breeze which becomes available when surplus heat recovery is introduced.

Section 4 describes the waste-heat boiler feed water treatment and shows the results obtained when working a Neckar water softening plant.

It will be observed that British units have been used throughout the investigation. The word "regenerator," which is commonly used for the method of heat recovery from the products of combustion leaving the setting, has been used instead of "recuperator," although the latter word would probably be more appropriate.

Section 1.—*Theoretical Considerations of the Heating of a Horizontal Regenerator Setting and the Quantity of Surplus Heat Available.*

In the following calculations there is no attempt to consider deeply the thermo-chemical equations involved, but to treat the subject from a fairly elementary point of view, and in order that this section be made more practical it is necessary to incorporate several figures taken from actual working, and these are indicated. The findings give at least an approximation of how heat is developed and utilized in the setting. In some instances assumptions are made because it is felt that if the subject is approached from a more advanced standpoint a certain amount of doubt may be forthcoming as to the accuracy of some of the figures. As an illustration, an assumed figure is taken for the actual amount of heat absorbed during the thermo-chemical reaction between water vapour and incandescent carbon present in the producer. This reaction being an endothermic one, an absorption of heat takes place. The actual amount of heat absorbed is found to vary according to temperature and nature of the zone of reaction. It follows therefore that a figure is taken approximating average conditions which exist during the working of the producer.

For the basis of the calculations in this section an ultimate analysis of a coke made from a Durham gas coal is taken and is summarized as follows:—

—	% By Weight.	1 Lb. of Coke Contains
Carbon	85·3	0·853 lb.
Hydrogen	0·9	0·009 ,,
Sulphur, combustible	1·5	0·015 ,,
Nitrogen	0·8	0·008 ,,
Ash	10·5	0·105 ,,
Oxygen (by difference)	1·0	0·010 ,,
	100·0	1·000 lb.
Gross calorific value, calculated	..	12,990 B.Th.U. per lb.

Products Formed by Admission of Primary Air to Producer.

It is assumed that during this first stage of combustion the whole of the carbon present in the coke substance is converted into carbon monoxide and the whole of the combustible sulphur is converted into sulphur dioxide. No allowance is made for the formation of sulphuretted hydrogen. The free hydrogen that is hydrogen not in combination with oxygen in the coke substance is liberated. During this stage it is found that 5·009 lbs. of dry primary air will be required to complete the foregoing reactions. Hence the volume of dry primary air required per ton of coal carbonized is 22,000 c.ft. measured at N.T.P., based upon a fuel consumption of 360 lbs. of coke per ton of coal. In addition to the quantity of air required, a definite amount of water vapour accompanies this weight of air, and the actual amount will depend upon the humidity of the surrounding atmosphere. With the water present in the coke substance, and assuming that the relative humidity of the air drawn into the producer is 65% at 60° F., it is found that 0·046 lb. of water vapour will pass over the incandescent coke. No allowance is made for the evaporation of water from the ashpan. As this water vapour travels over the incandescent coke it will be transformed according to the water gas reaction into combustible constituents with a subsequent absorption of heat. The quantity of heat absorbed is accounted for in the calculations for ascertaining the possible elevation in temperature of the gaseous products leaving the producer. The heat taken up in this way will be recovered during combustion in the setting, and there will be no loss or gain finally in the total heat units present in the products of combustion.

TABLE I.—*Gaseous Products Formed During this Stage of Combustion per Lb. of Coke Consumed in the Producer.*

—	Weight in Pounds.	Composition by Weight. %	Composition by Volume. %	Volume in C.Ft. at N.T.P.
Hydrogen	0·013	0·2	3·0	2·33
Carbon monoxide	1·990	33·8	32·9	25·49
Sulphur dioxide	0·030	0·5	0·2	0·17
Nitrogen	3·865	65·5	63·9	49·56
	5·898	100·0	100·0	77·55

The calculated gross calorific value of the producer gas formed under these conditions is found to be 123·0 B.Th.U. per c.ft. at N.T.P. It follows from the table that the total weight of dry producer gas formed is 5·898 lbs., and the volume 77·55 c.ft. at N.T.P.; hence the volume of dry producer gas required per ton of coal carbonized is 27,920 c.ft. measured at N.T.P. when the fuel consumed is 360 lbs. of coke per ton of coal carbonized.

The calorific intensity of the hot gaseous products leaving the producer is ascertained by dividing the total heat available during this stage of the combustion by the sum of the heat capacities of the gaseous constituents at constant pressure. The total heat available is the heat given out during the formation of carbon monoxide and sulphur dioxide, less heat losses, which include radiation, &c., heat absorbed during the water gas reaction, and the heat content of the ashes taken from the ashpan. From this determination it is found that the maximum calorific intensity possible under these conditions is in the region of 2,150° F., according to theory.

Products Formed by Admission of Secondary Air to Combustion Chamber.

The temperature of the secondary air entering the base of the regenerator is taken as 60° F., and during its flow through the regenerator flues it acquires heat from the incandescent brickwork which has been heated to a large extent by the hot products of combustion leaving the setting. It is found that by preheating the secondary air in this way 22·5% of the total heat value of the original coke is returned to the setting. When the secondary air enters the combustion chamber it is assumed that the hydrogen and carbon monoxide present in the producer gas are completely converted to water vapour (steam) and carbon dioxide. For complete combustion of the producer gas under these conditions it is found that 5·382 lbs. of dry secondary air are necessary. The amount of water vapour accompanying this weight of air is 0·037 lb. assuming the relative humidity of the air is 65% at 60° F. The volume of dry secondary air required per ton of coal carbonized is 24,000 c.ft. measured at N.T.P., if the fuel consumption is 360 lbs. of coke per ton of coal carbonized.

TABLE 2.—*Gaseous Products Formed During the Second Stage of Combustion per Lb. of Coke Consumed in the Producer.*

—	Weight in Pounds.	Composition by Weight. %	Composition by Volume. %	Volume in C.Ft. at N.T.P.
Carbon dioxide . .	3·124	27·6	19·4	25·49
Nitrogen	8·010	70·7	78·2	102·70
Sulphur dioxide . .	0·030	0·3	0·1	0·17
Water vapour . . .	0·153	1·4	2·3	3·05
	11·317	100·0	100·0	131·41

The volume of the products formed on the complete combustion of the producer gas under consideration is found to be 47,310 c.ft. (moist) at N.T.P. per ton of coal carbonized when based on a fuel consumption of 360 lbs. of coke per ton of coal carbonized. The calorific intensity of the gaseous products leaving the combustion chamber is ascertained by dividing the total heat available from the combustion of the hydrogen and carbon monoxide, less heat losses which include radiation, &c., by the sum of the heat capacities of the gaseous products formed under constant pressure.

From this calculation it is found that the elevation in temperature at this stage of the combustion lies in the region of 4,000° F. This figure is purely theoretical and never obtained in practice, due to the fact that there is a constant flow of heat from the products of combustion to the refractory material. If the heating gases after circulating through the setting are assumed to leave the regenerators at a temperature of 1,450° F. (this figure is obtained from practical working of eight-hour charges with an average combustion chamber temperature of 2,500° F. (1,370° C.)) it is found that they carry away an equivalent amount of heat to the extent of 4,218 B.Th.U. per lb. of coke consumed in the producers. If this figure be deducted from the total heat available in the combustion chamber it is found that the actual heat used up in the setting for maintaining the temperature of the retorts during carbonization of the coal charge is 56·5% of the total heat value of the original coke fed into the producer.

With a waste-heat boiler in operation a certain amount of heat can be taken as irrecoverable, due to the heat content of the flue gases leaving the boiler unless economizers are installed and a portion of this heat utilized. If the temperature of the flue gases at the outlet of the boiler is 500° F. (this figure is taken from practice), the heat value of the gases leaving the boiler is found to be 1,370 B.Th.U. per lb. of coke consumed in the producers, assuming, as before, the same fuel consumption in the producers. It may be said therefore that the surplus heat available for recovery in a waste-heat boiler is 4,218 B.Th.U., which is the heat value of the gases leaving the setting, less 1,370 B.Th.U., which can normally be taken as irrecoverable—leaving a figure of 2,848 B.Th.U. per lb. of coke consumed in the producer, or 21·9% of the total heat value of the original coke.

Appendix to Section 1.—*Effect of Excess Secondary Air upon Efficient Working of Setting when Draught Conditions Remain Unaltered.*

For the purpose of these calculations irregularities which may occur during the working of the producer, such as an easy burning coke, variations in the depth of the fuel bed, &c., and their possible effect upon the quantity and quality of the producer gas made have not been considered. It is assumed also that induced draught conditions are available and that a constant suction can be maintained on the setting. It will be agreed that with a steady suction an easier regulation of the secondary air supply may be expected and a more efficient heating of the setting obtained.

In this appendix the basis of the calculations is the necessary draught required under ideal working conditions for handling the theoretical quantity of secondary air to complete the combustion of the producer gas made. It will be understood that the total weight of products entering the combustion chamber—namely, the weight of producer gas *plus* the weight of secondary air—should not vary if the draught conditions remain unaltered. Consequently, if the weight of secondary air is increased under these conditions there will be a corresponding reduction in the weight of producer gas entering the combustion chamber. With this reduction in the weight of producer gas it will be understood that there will be less heat available for heating the setting. The figures given in Table 3 show the effect of varying the amounts of excess air upon the weight of producer gas made and also upon the heat available for heating the setting when the weight of secondary air entering the combustion chamber is greater than that required for complete combustion with the draught conditions unaltered.

TABLE 3.—*Effect of Excess Air upon Weight of Producer Gas and its Heat Value when Draught Conditions Remain Unaltered.*

Actual excess air entering combustion zone, % by weight .	*Nil*	10·0	21·1	47·0	121·2
Composition of the producer gas—					
Carbon monoxide, lbs. . .	1·990	1·899	1·807	1·625	1·259
Hydrogen . . . ,, . .	0·013	0·012	0·012	0·010	0·008
Nitrogen . . . ,, . .	3·865	3·687	3·511	3·155	2·444
Sulphur dioxide . ,, . .	0·030	0·029	0·027	0·024	0·019
Total weight ,, . .	5·898	5·627	5·357	4·814	3·730
Secondary air required for complete combustion (moist), lbs.	5·419	5·173	4·922	4·424	3·430
Weight of excess secondary air (moist), lbs.	*Nil*	0·517	1·038	2·079	4·157
Potential heat value of the producer gas, B.Th.U. gross .	9,527	9,091	8,650	7,777	6 030
Composition by volume of the products leaving the combustion zone—					
Carbon dioxide, % . . .	19·39	18·45	17·33	15·48	11·84
Nitrogen . . ,, . . .	78·16	78·27	78·57	78·75	79·09
Oxygen (excess) ,, . . .	..	0·92	1·81	3·61	7·15
Sulphur dioxide ,, . . .	0·13	0·12	0·11	0·10	0·08
Water vapour . ,, . . .	2·32	2·24	2·18	2·06	1·84
	100·00	100·00	100·00	100·00	100·00

Apart from the reduction in the weight of the producer gas entering the combustion chamber and the heat available there is another aspect of the effect of allowing excess air to enter the combustion zone. When excess air is present the products of combustion will contain free oxygen, the amount of which depending upon the quantity

of air allowed to go forward. If towards the end of the carbonizing period of the coal charge it is possible to have negative pressure in the retorts, the products of combustion of the producer gas which contain the free oxygen may be drawn into the retorts through open joints or because of the permeability of the refractory materials, with the result that immediate combustion takes place between the gases evolved during this part of the carbonization and the free oxygen. What effect this state may have upon the actual thermal yield of coal gas and the quantity and quality of the residuals is unknown; yet it does seem likely that these conditions exist during ordinary working of the settings. It need not be emphasized, therefore, that strict technical control in this direction is necessary in order that excess secondary air be prevented from entering the combustion zone.

The difficulty of obtaining an average sample of the products of combustion leaving the setting in order that the amount of air may be determined is fully realized, and one suitable method is for samples to be taken at predetermined intervals over the coking period of the producer at a point near the top of the regenerator flues. By taking the samples at the top of these flues any ingress of air which may take place while the gases are travelling through the flues is prevented from interfering with the results of the analyses. From Table 3 it will be seen that the figures given for the carbon dioxide content of the flue gases leaving the setting give an indication as to the amount of excess air drawn into the setting. For example, if the carbon dioxide content of the flue gases leaving is 15·5%, the total amount of air in excess of that required for complete combustion will be 47·0% by weight.

Section 2.—*Practical Working of a Waste-Heat Boiler Operating on a Bench of Ten Horizontal Regenerator Settings Containing Eight Retorts per Bed and Carbonizing 100 Tons of Coal per 24 Hours with Eight-Hour Charges at an Average Combustion Chamber Temperature of 2,500° F. (1,370° C.).*

The boiler contains 282 flue tubes with a total heating surface of approximately 2,000 sq. ft. The boiler fittings include the usual warning devices for high and low water levels, and the permissible working steam pressure is 120 lbs. per sq. in., the steam being superheated. The flue gases are drawn through the boiler, and the necessary suction is ensured by means of a "Sirocco" fan installation. The fan, which has water-cooled bearings, is direct-coupled to a vertical high-speed steam engine, the normal speed of which is 670 r.p.m. Exhaust steam from the fan engine after passing through an oil separator enters the reaction tank of a water softening plant. The waste gases on leaving the fan pass to a steel chimney, which is lined with firebrick so as to prevent corrosion taking place owing to the nature of the flue gases.

TABLE 4.—*Average Results During Test Run.*

Temperature of flue gases entering boiler	1,100° F.
Temperature of flue gases leaving boiler	500° F.
Steam pressure, lbs. per sq. in.	106
Superheated steam, degrees of superheat	206° F.
Gross evaporation of water per hour	3,365 lbs.
Temperature of feed water entering water softener	61° F.
Suction at inlet to boiler	0·75 in. w.g.
Suction at inlet to fan	2·25 in. w.g.
Net coke used in producers per hour	1,500 lbs.
Extraction efficiency	79·2%
Steam used by fan engine per hour	440 lbs.
Evaporation of water per lb. of coke used in producers, from and at 212° F.	2·95 lbs.
Steam generated per ton of coal carbonized, from and at 212° F.	1,062 lbs.

Section 3.—*Cost of Steam Generation from Surplus Heat, &c.*

Underlying the computation of the following costs of different methods of steam raising is the fact that from the point of view of general working conditions no two plants are exactly the same. With this in view it is understood that the figures given can only be taken as comparative. The results indicate very forcibly the economy which can be obtained in steam raising by utilizing surplus heat. The costs are calculated upon the normal rating of the boilers and do not show the possible adverse effects of minimum and maximum ratings in the case of the hand-fired Lancashire boilers.

TABLE 5.—*Steam Raising Costs of Hand-Fired Lancashire Boilers Using Coke Breeze Under Forced Draught Over a Period of Three Months.*

—	Two Lancashire Boilers, 30 Ft. by 8 Ft. 6 In. Dia., Working at 120 Lbs. per Sq. In. Pressure, Each Evaporating 4,500 Lbs. of Water per Hour.
Quantity of water evaporated	1,825,000 galls.
Capital outlay on plant which includes water softener	£3,400
	Cost per 1,000 Lbs. of Steam Generated. d.
Feed water	1·27
Softening	0·24
Boiler attendants	1·65
Coke breeze	8·51
Cartage of fuel	1·01
Removal of ashes	0·26
Cleaning of boilers, repairs and maintenance, &c.	0·38
Total	13·32

TABLE 6.—*Steam Raising Costs of a Fire Tube Waste-Heat Boiler Over a Period of Three Months.*

Quantity of water evaporated	700,000 galls.
Capital outlay on plant which includes water softener	£2,452
	Cost per 1,000 Lbs. of Steam Generated. d.
Feed water	1·46
Softening	0·11
Attendance to boiler	0·65
Repairs and maintenance, which includes cleaning of tubes, &c.	0·39
Total	2·61

TABLE 7.—*Summary of Steam Raising Costs.*

—	8 Ft. 6 In. Dia. Hand-Fired Lancashire Boilers Using Coke Breeze.		Waste-Heat Boiler.	
	Excluding Interest and Depreciation.	Including Interest and Depreciation.	Excluding Interest and Depreciation.	Including Interest and Depreciation.
	d.	d.	d.	d.
Cost per 1,000 lbs. of steam generated	13·3	14·4	2·6	4·7
Cost per ton of steam generated	29·8	32·3	5·8	10·5

Interest and depreciation is calculated at the rate of 10% per annum.

When steam raising in waste-heat boilers is introduced a certain amount of surplus breeze becomes available which normally would be used for steam generation in Lancashire boilers, and must therefore be utilized in some other way.

The term "breeze" is used to signify coke which will pass through a $\frac{1}{2}$-in. mesh sieve. When comparing the relative evaporations of the waste-heat boiler with that of a hand-fired Lancashire boiler in terms of breeze, it is found that for every 24 hours the waste-heat boiler is at work approximately $7\frac{3}{4}$ tons of breeze must be accounted for. This result is based on an average evaporation of 4,300 lbs. of water per hour from and at 212° F. in the case of the waste-heat boiler, and assuming a hand-fired Lancashire boiler, with an average evaporation of 6 lbs. of water per lb. of coke breeze, from and at 212° F.

Methods of Utilizing Surplus Breeze.

(A) *Use of Breeze in Internal Producers.*—On first consideration of this suggestion it would appear that the addition of breeze to the coke used in the producers would materially affect the efficient working of the setting and cause excessive clinker formation due to the segregation of coke dust of high ash content. An increasing amount of breeze was added at a predetermined rate until as much as 10% to 15% of the fuel used in the producers was breeze, and very satisfactory results have been obtained. It was found that a certain amount of supervision is necessary in

order that the material be evenly distributed over the full area of the fuel bed. No appreciable difference was noticed in the heating of the settings, nor was there any sign of increased clinker formation since the inception of breeze. The producers are of the usual step-grate type.

(B) *Use of Breeze in Water Gas Manufacture.*—The possible adverse effect of adding breeze to the coke fed into the generators of the water gas plants was thought to be prohibitive because the nature of the fuel would not only cause an increased fuel consumption per 1,000 c.ft. of gas made, but reduce the throughput of the plant. Any excess of breeze would probably deaden the fire in the generator and impede the flow of gas and also an excessive amount of dust would collect at the bottom of the scrubber. When varying amounts of breeze were added to the coke used in the plant it was found that when the percentage was greater than 5% not only was there a drop in throughput but increased trouble due to excessive clinker formation. Another drawback to large quantities of breeze was the fact that a great deal of dust was scattered over the neighbouring buildings during the blow periods. At present satisfactory results are obtained by adding 5% of breeze to the coke in such a way that the breeze is sandwiched between the coke in the buggies feeding the generators.

(C) *Addition of Coke Dust Passing ⅛-in. Mesh Sieve to Coking Coals.*—The results of this suggestion show how advantage can be taken of the fact that most coking coals contain an excess of binding material which can be utilized during the carbonization of a mixture of coal and a practically inert material. The experiments were carried out in a one-thousandth part of a ton carbonization assay plant, and it was found that a mixture containing 5% of air-dried coke dust gave a coke of good structure and appearance. Various mixtures were carbonized, but it was found that the mixture mentioned gave the most satisfactory product. The proximate analysis of the coal used during the experiments is as follows:

	%
Moisture	1·5
Ash	6·4
Volatile matter, *less* moisture	31·1
Fixed carbon	61·0
	100·0
Sulphur, combustible	1·90

The coal used was crushed so that it passed a ¼-in. mesh sieve, and was mixed with the various quantities of coke dust by hand and carbonized at a temperature of 1,800° F. During the carbonization of the mixtures observations were taken regarding the evolution of gas from the charges. It was found that during the early stages of the carbonization of the mixtures there was a much greater evolution of gas from the charge than when the coal was carbonized alone. This phenomenon may be due to better heat penetration when the coal and coke dust mixtures were being carbonized, because there would probably be a reduction in the plastic layer which is so prominent during the early stages of the carbonization of coal.

TABLE 9.—*Analyses of the Cokes Made during the Experiments.*

	Coke Made from Coal Only.	Coke Made from Mixture of Coal and 5% Air-Dried Coke Dust.
	%	%
Moisture	0·2	0·2
Ash	10·1	11·0
Volatile matter, *less* moisture	0·6	0·4
Fixed carbon	89·1	88·4
	100·0	100·0
Sulphur, combustible	1·62	1·73

Section 4.—*Waste-Heat Boiler Feed Water Treatment*

The water supply of the East Durham area is obtained from wells sunk to a considerable depth. The water, which percolates through magnesian limestone, acquires large quantities of the carbonates of calcium and magnesium, which, although practically insoluble in water alone, are dissolved in the form of bicarbonates which are soluble owing to the presence of carbon dioxide in the water. The carbon dioxide in the water has been taken up from the atmosphere and from the decomposition of organic matter present in the surface soil. A typical analysis of the water before treatment is summarized:

Total solids	41·2 pts	per 100,000 pts. of water
Chlorine	3·2 ,,	,, ,, ,,
Alkalinity as $CaCO_3$	28·0 ,,	,, ,, ,,
Calcium oxide	13·6 ,,	,, ,, ,,
Magnesium oxide	6·4 ,,	,, ,, ,,
Sulphur trioxide	4·5 ,,	,, ,, ,,
Nitrate, silica, iron, &c.	Traces	

Total hardness . . . . . 27·6 grains per gallon, of which 19·3 grains are temporary and 8·3 are permanent.

It will be observed from this analysis that a very efficient method of softening treatment is necessary before the water will be suitable for boiler use in order that scale formation and concentration of salts within the boiler be reduced to a minimum. It need not be emphasized why scale formation should be prevented in a boiler of the class under review. When comparing the heat conductivity coefficients of iron and scale respectively, it is discovered that in the case of iron the coefficient lies in the region of 35 B.Th.U. per sq. ft. per hour per ft. thickness per 1° F. temperature difference, whereas scale has a coefficient of only 1 to 1½ B.Th.U. per sq. ft. under same conditions, depending, of course, on the nature and the porosity of the scale. It is obvious, therefore, that scale formation—even of egg-shell thickness—will appreciably reduce the overall heat transfer coefficient and consequently the economical working of the boiler. The efficiency of this type of boiler depends to a large extent upon the velocity at which the flue gases pass through the boiler tubes and the effective heating surface, and if scale formation is allowed to proceed the evaporation capacity of the boiler will be correspondingly reduced.

The plant adopted for treatment of the feed water for the waste-heat boiler was that of the Neckar Company. It has given entire satisfaction since it was installed, and, from the reports sent in by the Boiler Insurance Company, the condition of the tubes on the water side of the boiler have always been found in a very satisfactory state. With this class of plant in operation there are many advantages to be gained when compared with the ordinary lime-soda treatment. For example, a large proportion of the soluble gases present in the feed water, which may cause corrosion at a later stage, are driven off during the heat treatment in the reaction vessel where the water is raised to a temperature approaching 200° F. Further, the increased temperature at which the water is treated accelerates the speed of precipitation of the salts during the softening process and also accounts for a larger quantity of calcium sulphate being precipitated without the use of reagent because this salt has an inverted solubility curve. It follows also that due to increased temperature the viscosity of the water will be diminished, and, therefore, quicker settlement of the precipitated salts will be expected. The conclusion is reached, therefore, that the effect of temperature treatment upon the feed water is a very important aspect of the process.

The following laboratory experiments show that in the case of the water under consideration it is possible to reduce the temporary hardness of the feed water by at least 11° by simple heat treatment alone without bringing the water to its boiling point. The experiments were carried out under identical conditions, and in each case the treatment of the water lasted for two hours. Temporary hardness of the feed water before treatment, 19·3 grains per gallon (calculated as calcium carbonate).

Average Temperature of the Water during Heat Treatment.	Temporary Hardness of the Water after Heat Treatment.
120 °F.	18·2 grains per gallon
130 ,,	17·0 ,, ,,
140 ,,	15·4 ,, ,,
150 ,,	14·5 ,, ,,
160 ,,	12·7 ,, ,,
170 ,,	11·5 ,, ,,
180 ,,	8·5 ,, ,,
190 ,,	8·2 ,, ,,
200 ,,	8·1 ,, ,,

The results of these experiments indicate that the temperature best suited for reduction of the temporary hardness in the feed water is that when the temperature is maintained above 180° F.

Outline of Process and Results of Working.

The initial treatment of the water is carried out in a vertical cylindrical vessel known as the reaction tank, where anhydrous sodium carbonate is added at a pre-

determined rate to ensure that the whole of the permanent hardness in the feed water is removed. The quantity added is such that the alkalinity of the boiler water is kept uniform and is equivalent to 75-80 grains of sodium carbonate per gallon of water. The temporary hardness of the feed water is removed to a large extent by heat treatment in the reaction tank. The temperature of the water in this tank is maintained by returning a portion of the sludge from the waste-heat boiler by means of a continuous sludge return. Another additional source of heat which enters the reaction tank is that of the exhaust steam from the fan engine which contains approximately 80% of the initial heat value of the steam entering the engine.

The actual quantity of sludge returned to the reaction tank of the softener is regulated by means of a quadrant valve fitted to the continuous sludge return pipe, and the concentration of salts in the boiler are therefore under control. The sludge contains a certain amount of sodium hydroxide which has been formed inside the boiler, the actual quantity present depending upon the concentration of sodium carbonate in the boiler water and the temperature and pressure conditions within the boiler. The presence of sodium hydroxide in the sludge returned from the boiler helps in the softening of the water. Under existing working conditions the hardness of the feed water entering the boiler has been very consistent and is under 1 grain per gallon. In Table 8 the results of six months' working of the softening plant are given, and show very clearly the successful operation of the process.

TABLE 8.—*Results of Six Months' Working of the Neckar Water Softening Process.*

Month.	Average Water Evaporated by Boiler per Hour. Galls.	Anhydrous Sodium Carbonate Used per 1,000 Galls. lbs.	Boiler Water Tests. Alkaly. Grains of Na_2CO_3 per Gall.	Boiler Water Tests. Density. °Tw.	Feed Water Tests. Alkaly. Grains of Na_2CO_3 per Gal.	Feed Water Tests. Hardness Grains of $CaCO_3$ per Gall.	Feed Water Tests. Temperature of Water in Reaction Tank. °F.
Jan. . .	330	1·05	89·0	1	34·0	Less than 1°	198
Feb.. .	332	1·14	71·7	¾	29·6	,,	195
March .	334	1·12	77·6	⅞	31·1	,,	194
April .	328	1·05	70·7	¾	28·8	,,	195
May . .	300	1·10	68·1	⅞	29 6	,,	198
June. .	272	1·16	63·5	⅞	29·6	,,	195
Average.	316	1·10	73·4	¾	30 5	,,	196

These results indicate the working of the softening plant when approximately 25% of the boiler water and sludge were returned to the reaction tank. This quantity is probably greater than that which would normally be required, and is in excess of the quantity used when the plant was first installed. It was found from the working of the plant that the most beneficial results were obtained when the sludge returned to the softener was increased to the amount mentioned. By increasing the amount of sludge returned from the boiler to the softener, the conditions within the boiler are changed, the boiler water becoming less dense, and, therefore, producing a state which would tend to mitigate the formation of scale. Possibly a distinct disadvantage of increased sludge return is the fact that a greater loss of heat due to convection, &c., from the water softening plant will be evident. The efficiency of the boiler plant will no doubt be affected by this loss of heat; yet considering that under these conditions scale formation will be reduced to a minimum, it can be expected that this loss of heat will be counteracted by better heat transference between the flue gases and the water inside the boiler when the tubes are in a cleaner state.

I take this opportunity of expressing my sincere indebtedness to Mr. Charles Dru Drury, Engineer and Director to the Sunderland Gas Company, for helpful advice and kindly criticism not only of this paper but also during the years of my technical training.

Discussion.

The CHAIRMAN (Mr. F. P. Fall, Sunderland), opening the discussion, congratulated the author on his paper and the manner in which he had treated his subject. Referring to the waste-heat boiler installation, Mr. Fall asked if the author had had any experience in glass silk covering heat insulation as compared with an 85% magnesia composition. Mr. Kirkwood's summary of steam raising costs between the Lancashire and waste-heat boilers showed those for the latter to be half those for the former. The figures should be modified as far as depreciation was concerned, as it had to be remembered that the Lancashire boiler was purchased in the expensive days of 1920, while the waste-heat boiler was bought in 1929 when prices had come down. Regarding the water softening plant, it was surprising to find as much as 25% of the boiler water and sludge being returned to the reaction tank. The makers put forward a figure of only 5%, but this would vary, of course, according to local conditions.

Mr. C. S. READ (Washington) asked what type of heat insulation was used at Sunderland between the settings and waste-heat boiler; also what insulation was used elsewhere to prevent loss by radiation.

Mr. S. A. WIKNER asked what method was used to maintain the draught when the flue gases entered the boiler at 1,100° F. and left at 500° F.

CO_2 Content of Flue Gases.

Mr. F. NICHOLLS (Gateshead), referring to the figure of 16% for the carbon dioxide content of the flue gases, asked if there was any real basis for that figure. Some people seemed to get much less than that, and it never seemed to get higher than from 10 to 14%. What type of oil separator did they use, and how effective was it? Referring to the respective costs of the Lancashire and waste-heat boilers, Mr. Nicholls said the principal item for the Lancashire boiler was the coke breeze. If there was no market for breeze then it had no value and could not be charged at the figure of 8·51d. per 1,000 lbs. of steam generated. That would bring the total cost for the Lancashire boiler down to about 4·8d. per 1,000 lbs. of steam, as compared with the 2·61d. for the waste-heat boiler. Whether the waste-heat boiler was worth while resolved itself into a question of what to do with the coke breeze if a waste-heat boiler was installed. Why was the cost of water softening in the Lancashire boiler more than double that for the waste-heat boiler?

Mr. J. K. PORTER said that the author had taken a temperature of 1,450° F. for the heating gases leaving the generators when perhaps 1,000° to 1,200° F. was a more usual figure.

The Author's Reply.

Replying to the discussion, Mr. KIRKWOOD said he had had no personal experience of glass silk for heat insulation. He agreed with Mr. Fall that in comparing steam-raising costs for the Lancashire and waste-heat boilers he should have taken the depreciation and interest items into greater consideration. Undoubtedly a return of 25% of boiler water and sludge to the reaction tank in the water softening plant seemed high, and it lent itself to greater heat losses; but they had definitely proved by exhaustive tests that it gave the best results. It was best to keep the hardness figure down to less than 1°. Mr. Read had asked about the insulation at the retort benches. Where there was no insulation he had taken readings, and the average temperature was 730° F., and where there was a layer of insulating bricks, it had been 570° F., a difference of 160°. He did not suggest that these were ideal figures. Where bricks could be got to stand up to the conditions, the effect of insulation was beneficial. At Sunderland they had only had insulation bricks for two years, and it was difficult to say quite what their value really was. In regard to Mr. S. A. Wikner's question as to the diminution in draught in the drop from 1,100° F. to 500° F. in the temperature of the flue gases for the waste-heat boiler, a high-speed steam engine was used. As to the use of coke breeze for steam-raising in Lancashire boilers he realized when submitting his comparative figures he was treading on soft ground. They were normal figures for the plant, however.

Replying to Mr. Nicholls, Mr. Kirkwood said he realized the difficulty of obtaining a reliable figure as to the percentage of carbon dioxide leaving the setting. His figures were the average for those he had taken out. As to the method of oil separation, they used the Holden and Brook installation, which they found very efficient. As to water softening, the cost for the Lancashire boiler per 1,000 lbs. of steam raised was 0·24d. and was done by a lime process, while the softening for the waste-heat boiler, carried out by another plant, was 0·11d. As to the cost of 8·51d. per 1,000 lbs. of steam raised for coke breeze, he had taken this as a comparative figure on the basis of 7s. per ton for breeze.

The temperature of 1,450° F. for the heating gases leaving the generators was the average figure arrived at after he had taken a large number of readings.

Scottish Junior Gas Association (Western District).

On Nov. 17 some sixty members of the Scottish Junior Gas Association (Western District) visited the works of the Forth and Clyde and Sunnyside Iron Company, Ltd., Falkirk. The visitors were received by Mr. Wm. Rankine (Director), Mr. James Brown (Deputy-Chairman, Allied Foundries, Ltd.), and Mr. John Brown (Director).

The making of the moulds for the castings was demonstrated, together with the enamelling, drying, and firing of the various cooker parts.

The visitors were afterwards entertained at tea, when Mr. James Brown, in giving them a welcome, said that he always had an admiration for the Gas Industry in their interest in allied industries, and he believed that the health and prosperity of the Industry was due to the co-operation of the Associations.

Mr. J. Greig, the President, thanked Mr. Brown and the Directors for the facilities afforded and the co-operation of such firms.

The Leeds Gas Order

At the Offices of the Board of Trade in London on Friday, Nov. 23, Mr. J. F. RONCA (Director of Gas Administration) held an Inquiry concerning the Application of the Leeds Corporation for a Special Order under Section 10 of the Gas Regulation Act, 1920.

The Corporation was represented by Sir Harry Pritchard (Parliamentary Agent), Mr. C. S. Shapley (Engineer and Manager, Corporation Gas Department), and Mr. Thomas Thornton (Town Clerk). The only opponent was Electrical Distribution of Yorkshire, Ltd., for whom Mr. Dodds (of Messrs. Lewin, Gregory, & Co., Parliamentary Agents) appeared together with Mr. W. B. Woodhouse (Managing Director of the Company).

Sir HARRY PRITCHARD said that the only object of the Order was to extend the limits of supply of the Leeds Corporation Gas Department into the parish of Bramhope, which adjoined the present limits of supply of the Corporation Gas Department and had a population of 670. The Draft Order also contained a number of routine clauses; but to the Order, as such, there was no opposition. He added that the West Riding County Council had prepared a scheme in which it was proposed at some future time, subject to the sanction of Parliament, to add the parish of Bramhope to Leeds. At the moment, however, the parish was outside the city boundaries.

Dealing with the opposition of the Electricity Supply Company, Sir Harry said the request was made that there should be inserted in the Order a clause similar to that which was inserted in the Gas Light and Coke Company's Act of 1933, which would prohibit the Corporation, as a housing authority, from imposing restrictions within Bramhope, as to whether tenants of Corporation houses and property should use electricity for heat, light, and power. In other words, the tenants should be allowed to use whichever form of heat, light, and power they chose. At the moment the Corporation owned no property in Bramhope, and there was very little probability of any houses being built there by the Corporation. Moreover, there was no suggestion by the opposition that the Leeds Corporation had ever sought to impose such restrictions upon any of their tenants elsewhere. Dealing with the clause in the Gas Light and Coke Company's Act and also other Acts such as Kettering, the South Metropolitan Gas Company, and the Brighton, Hove, and Worthing Gas Company, Sir Harry Pritchard pointed out that in all these cases there were specific allegations that the local authorities owning electricity undertakings in the areas of the gas companies concerned had in fact imposed restrictions of the nature complained of, and it was for that reason, presumably, that Parliament had granted the clauses prohibiting this being done. Apart from the fact that no allegation was made against the Leeds Corporation in the present case, Sir Harry Pritchard contended that the Board of Trade had no power under the Gas Regulation Act of 1920 to insert such a clause, and he suggested that any such action on their part would be *ultra vires*. Referring to Section 10 of the Act of 1920, he pointed out the scope of the various sub-sections—none of which, he contended, could possibly apply to the insertion of such a clause as that now proposed—and then pointed to the words "And make such supplementary and consequential provisions as appear necessary to give full effect to the Order." Surely, he said, the imposition of a restriction on the Corporation of Leeds as a housing authority acting under Parliamentary powers, could not be regarded as supplementary and consequential provisions to give effect to the Order proposed in this case.

Finally, Sir Harry Pritchard called attention to the Gas Undertakings Act of 1934, Section 27 of which, as he read it, protected gas companies from any such action with regard to tenants of their properties by local authorities owning electricity undertakings, but this did not cover electricity supply companies as against local authorities owning gas undertakings, and he suggested that if electricity supply companies had a grievance in this respect they had two alternative courses. In the first place, they must prove unreasonable action on the part of a particular local authority, or they must try to persuade the Government to include in the Electricity Bill now before Parliament a provision of a similar nature to that in Section 27 of the Gas Undertakings Act of 1934.

Mr. DODDS, speaking on behalf of the Electrical Distribution of Yorkshire, Ltd., asked that there should be inserted in this Order a clause similar to that which appeared in the Kettering Act of 1932 with the necessary modifications to apply it to the present case, the intention being, of course, that the clause should only apply to the parish of Bramhope. All the Electricity Company was asking was that gas and electricity should be able to compete on equal terms.

The DIRECTOR commented on the fact that in the case of those Acts of Parliament in which the clause now asked for had been inserted, it had been proved to the satisfaction of Parliament that unreasonable restrictions had been placed upon tenants of Corporation property. He also asked Mr. Dodds' view as to the point raised concerning the lack of authority on the part of the Board of Trade to grant such a clause.

Mr. DODDS replied that in his view there was no question that the Board of Trade had the power to insert any provision which it thought reasonable for the protection of those who might be affected under any such Order.

Mr. *W. B. Woodhouse* (Managing Director, Electrical Distribution of Yorkshire, Ltd.) expressed the view that it would be inequitable if an electricity supply undertaking was not given the same protection as was given to gas companies in the Gas Undertakings Act of 1934.

Sir HARRY PRITCHARD, in his concluding remarks, said that undoubtedly this was a matter of general public policy, but it must be dealt with by a provision in a general Act which, if Parliament thought fit, would give the same protection to electricity supply companies as had been given to gas companies in the Gas Undertakings Act of 1934.

This closed the Inquiry, and the Director will report to the Board of Trade in due course.

Oriental Gas Company

ORDINARY GENERAL MEETING OF PROPRIETORS

The Annual Ordinary General Meeting of the Oriental Gas Company, Ltd., was held at the Company's Office, Finsbury House, Blomfield Street, E.C. 2, on Thursday, Nov. 22, 1934—Mr. S. HUNTER JONES, M.Inst.C.E. (the Chairman of Directors), presiding.

The SECRETARY (Mr. S. Rainer) read the notice convening the meeting, together with the Auditors' report on the accounts for the year ended June 30, 1934.

The Chairman's Address.

The report and accounts having been taken as read by general agreement of those present, the CHAIRMAN, in moving the resolution for their adoption, said:

The accounts we present to you to-day reflect the decrease in revenue for a full year as a result of the reduction of As. 8 per 1,000 c.ft. made to the ordinary consumers in the price of gas in the Spring of 1933; and although the decrease is considerable, amounting to some £6,000, I am glad to say that we have succeeded in meeting our dividend requirements out of our Revenue Account and are enabled to recommend to you the same dividend as last year.

We have also thought it wise to increase our Reserve Fund by allocating to it the sum of £10,000 out of the balance of the Net Revenue Account.

The sale of gas shows a slight reduction of rather less than 1%, due, I fear, to the continued state of trade depression in Calcutta.

It will interest you to know that since the time when I first knew this Company, nearly 25 years ago, the sale of gas to private consumers, which was then only about 29% of the whole sale, has risen to a figure almost approaching the total sale of gas to public authorities and private consumers at that time—in other words, a 70% increase. This is, I am sure you will feel, a very great tribute to the energy and enterprise of our staff in India. Although in a tropical climate, such as the Indian climate, gas for inside lighting is not favoured by reason of its heat, yet the field of use of gas in cooking, water heating, and industrial purposes of various kinds has been a steadily expanding one, and is one in which I think gas can hold its own with its various competitors, electricity, oil, and coal.

Turning to the accounts, and in particular to the Revenue Account, the expenditure on manufacture is less than the previous year by some £3,300. In the Distribution Department the expenditure is more by about £4,800. Expenditure on public lamps is less by £355. Rents, rates, and taxes are up by £1,314. Under the heading of Management the charges are much the same, being slightly more by £179. Summarizing figures, the total expenditure on the Revenue Account is more by £2,472.

On the receipts side of the account the revenue from gas is less by £6,239; the receipts for residual products are down by some £1,720; and the balance of the account is less than that of the previous year by £10,459.

Passing to the Net Revenue Account, you will observe, as I have already stated, that an allocation to the Reserve Fund of £10,000 has been made. The bank interest amounts to £395, as compared with £303 last year; the interest on investments is £878, as compared with £828 the previous year; the exchange amounts to £6,088, as compared with £6,600 previously; and the balance of the account is £108,027, as compared with £110,125.

The Reserve Fund now stands at £30,000; the Depreciation Account remains as heretofore at £50,000; the Renewals Suspense Account is also stationary at £17,000; and the Exchange Equalization Account remains as before at £5,009.

The coal carbonized during the past year amounted to 42,493 tons, as compared with 43,192 tons the previous year. The

coke sold was 18,675 tons, as compared with 18,468 tons previously. The breeze sold was 129 tons, as compared with 261 tons. The tar sold amounted to 587,107 gallons, as compared with 499,691.

The Balance-Sheet.

Turning to the balance-sheet, the capital expenditure up to date remains, as hitherto, at £430,669. Cash at the Company's Bankers and in hand is £38,715, as compared with £29,557 the previous year. The investments stand on our books at £26,139 as last year, the market value being, at June 30 last, £31,641. Amounts owing by the Company for coals, &c., are £8,650, against £8,351, and the amounts due to the Company for gas, residuals, &c., are £2,248, as compared with £3,195.

So much for the accounts, which I trust you will consider satisfactory.

The Manager reports, as you will see stated on the face of the accounts, an addition in the number of gas appliances sold or installed during the year of 762. In his general remarks he states that the business relations of the Company with its customers, including public bodies, have been quite satisfactory, and, although we have to record a slight decrease in the sale of gas, there are indications that we may expect, in the future, growth of consumption in the southern industrial area of Calcutta, for which we have been making preparation by considerable extensions of our mains, and, given normal and peaceful trading conditions, I look forward to continued progress in the Company's operations both in Calcutta and Howrah.

That, gentlemen, concludes my remarks; but I cannot sit down without referring to the continued good work of our Manager and his Staff in India, as well as of the Home Staff in London, which will be the subject, as usual, of a separate vote.

Before proposing the adoption of the accounts I shall be pleased to deal with any questions you may wish to put.

No questions being raised by the shareholders, the CHAIRMAN formally moved the resolution for the adoption of the report and accounts, this being seconded by the DEPUTY-CHAIRMAN (Mr. B. W. Ellis, A.M.Inst.C.E.), and carried unanimously.

Dividends.

The CHAIRMAN thereafter moved the payment of a dividend of 4½%, free of income-tax, making 8%, free of income-tax, for the year.

This was seconded by Mr. H. H. MACLEOD and unanimously agreed to.

Re-election of Directors and Auditors.

The CHAIRMAN moved the re-election of the two Directors retiring by rotation—namely, Mr. H. H. Macleod and Mr. W. G. Bradshaw—remarking that nothing he could say was necessary to recommend these gentlemen to them for re-appointment.

Mr. B. M. GILL seconded this resolution, which was carried unanimously.

On the proposition of Mr. J. G. KING, seconded by Mr. H. FLETCHER, the Company's Auditors (Messrs. S. W. Savage and F. J. Bradfield) were unanimously re-appointed.

Votes of Thanks.

Mr. B. W. ELLIS said that it now fell to him, as it had in previous years, to make a very pleasant proposal—that was, a vote of thanks to the European and Indian staff of the Company in London and Calcutta. It was, he said, with considerable regret that they were losing two of their officers in Calcutta, Mr. E. Garsed (the Engineer and Manager) and Mr. Morrison. These gentlemen had been with the Company for many years and had done active and enterprising work. It was with very great regret that they would be parting with them; but they had earned their retirement, in which the Board wished them every happiness. To them and to the other members of the European and Indian staff, including Mr. Rainer and the London staff, he asked them to propose a very hearty vote of thanks.

Mr. W. G. BRADSHAW seconded the vote, which was carried unanimously.

Mr. S. RAINER, responding on behalf of the staff, said that he would have much pleasure in conveying to their Manager, Mr. Garsed, and his colleagues on the Indian staff, this expression of appreciation; while on behalf of himself and his London staff he thanked them.

Mr. W. PARKER proposed a vote of thanks to the Chairman for his conduct of the meeting and to all the Directors for their conduct of the business of the Company during the past year. The position of the Company, he said, was one of enormous strength, with considerable liquid assets and no liabilities worth mentioning.

Mr. F. J. BRADFIELD, in seconding this vote, also acknowledged with thanks his own and his colleague's re-appointment as Auditors. The reduction in their profit was mainly due, he observed, to the reduction which they had effected in the price of gas, which was a sign that the Directors were well aware of the two guiding principles of gas company administration—namely, first, to provide cheap gas to the consumers, and, secondly, to increase the reserves. That policy the Directors had carried out during the past year. They were fortunate in having so competent a Board to control their Company.

The CHAIRMAN briefly acknowledged the vote of thanks, which concluded the business of the meeting.

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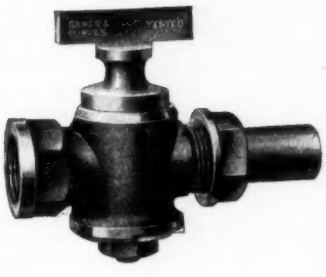

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BY ORDER OF THE DIRECTORS.

NEW ISSUE OF 4% PERPETUAL PREFERENCE STOCK.

SOUTH SUBURBAN GAS COMPANY.

Incorporated by Act of Parliament, 1858, as the Crystal Palace District Gas Company.

Directors.
CHARLES CARPENTER, D.Sc., *Chairman.*
BENJAMIN R. GREEN, *Deputy Chairman.*
HAROLD GUNDRY.
FRANK BUSH.
FRANK H. JONES, M.Inst.C.E.
ARTHUR M. PADDON, M.Inst.C.E.
ALEXANDER ROSS.
FRANCIS SADLER.

General Manager.
WILFRID WASTELL, F.C.I.S.

Engineers.
VERNON SIMMONDS, M.Inst. Gas E. (*Works*).
JOHN A. GOULD, M.Inst. Gas E. (*District*).

Secretary.
T. BROWN.

Brokers.
SEYMOUR, PIERCE & CO.

Bankers.
BARCLAYS BANK, LIMITED.

PARTICULARS AND CONDITIONS OF SALE BY TENDER OF

£200,000 4 per cent. PERPETUAL PREFERENCE STOCK,

Minimum price £105 per £100 Stock,

to rank after the Debenture Stocks and *pari passu* with the existing Preference Stocks.

THE DIRECTORS OF THE SOUTH SUBURBAN GAS COMPANY are prepared to receive on or before the 10th day of December, 1934, sealed tenders for £200,000 4 per cent. Perpetual Preference Stock.

The Stock may be tendered for in amounts of £10 or multiples thereof.

Tenders must be on the form accompanying the prospectus. No tender will be considered at less than the minimum price stated above.

A deposit of 10 per cent. of the nominal amount of the Stock tendered for must accompany the tender, the balance of the purchase money of all Stock allotted to be paid to the Company's Bankers, BARCLAYS BANK, LTD., at their Head Office, or any of their Branches, on or before the 29th December, 1934.

Dividend on the Preference Stock will commence to accrue from the 1st January, 1935. The existing Preference Stocks of the Company are quoted in the Stock Exchange Official List, and application will be made for the inclusion of the present issue.

The area supplied by the Company includes parts of the Metropolitan Boroughs of Lewisham, Camberwell and Lambeth and of the County Borough of Croydon, the whole of Beckenham, Penge, Bromley, Orpington, Bexley, Sevenoaks, the greater part of Chislehurst and Sidcup, Tonbridge, etc., and the important industrial districts of Crayford, Dartford, Erith, Northfleet and Greenhithe, comprising about 245 square miles.

The Company is associated with the South Metropolitan Gas Company and adjoins that Company's area of supply, which comprises the major part of the County of London south of the Thames. Under an agreement dated 28th January, 1927, the South Metropolitan Gas Company may purchase, at the average price received, up to five-twelfths of any Ordinary or Preference Capital issued by this Company.

The Company ranks fourth among the Metropolitan and Suburban Gas Undertakings. The sales of gas last year increased by 2¼ per cent. over the previous year and the increase has been well maintained during the present year. The demand for fittings and appliances continues to grow. The number of consumers now supplied by the Company totals 173,688 and shows an increase of 73 per cent. in the past ten years, excluding areas taken over during that time.

The proceeds of the present issue are required for repayment of loan by the Company's Bankers, to meet the cost of mains, appliances, etc., necessitated by the continuing rapid development of the Company's business, and for general purposes.

Under a contract dated 19th November, 1934, between the Company and Messrs SEYMOUR, PIERCE & CO., the whole of the Stock now offered has been underwritten for a commission of 1 per cent.

The paid up Capital of the Company is as follows:—

5%	Perpetual Preference Stock	£512,825
4%	Perpetual Preference Stock	300,000
5%	Ordinary Stock	1,543,795
5%	Redeemable Debenture Stock	39,400
5%	Perpetual Debenture Stock	888,587
4%	Perpetual Debenture Stock	100,000
6%	Redeemable Mortgage Debentures (repayable January 1st, 1935)	6,600
		3,391,207
	Premiums received on same	50,249
	Total receipts to date	£3,441,456

and the balance of the authorised capital remaining to be issued totals £499,497.

The Reserve Fund on the 31st December, 1933 stood at £94 668 6s 2d.

The Accounts of the Company are made up yearly to the 31st December; dividends on the Preference Stock will be payable half-yearly in March and July and a full half-year's dividend will be payable on 31st July next.

The yield at various prices would be:

At 105	£3 16 2
,, 106	3 15 6
,, 107	3 14 9
,, 108	3 14 1
,, 109	3 13 5
,, 110	3 12 9
,, 111	3 12 1
,, 112	3 11 5
,, 113	3 10 10
,, 114	3 10 2
,, 115	3 9 7

If tenders are received for a larger amount of Stock than that proposed to be issued, tenders at the lowest price accepted will be subject to diminution.

All Stock allotted when fully paid will be registered in the Company's books, and certificates issued free of expense, in the name of the person tendering, or his or her nominee, after which it will be transferable by deed in the usual way.

If no allotment is made, the deposit will be returned in full; and in case of partial allotment, the balance of the deposit will be applied to the balance of the purchase money due.

Interest at the rate of 10 per cent. per annum will be chargeable upon any balances of purchase money unpaid by the 29th December, 1934.

Tenders must be delivered by or before 12 o'clock noon on Monday, 10th December, 1934

Copies of this Prospectus may be obtained at the Chief Office of the Company, Lower Sydenham, S.E.26, at any of the Showrooms as under:—

97, SYDENHAM ROAD, SYDENHAM, S.E.26
2, DARTMOUTH ROAD, FOREST HILL, S.E.23
53, WESTOW HILL, UPPER NORWOOD, S.E.19
11, HIGH STREET, SOUTH NORWOOD, S.E.25
24, HIGH STREET, BECKENHAM, KENT
75, HIGH STREET, BROMLEY, KENT
143, HIGH STREET, ORPINGTON, KENT
86A, STATION ROAD, SIDCUP, KENT
16, CENTRAL PARADE, WEST WICKHAM, KENT
14, PIER ROAD, ERITH, KENT
16-18, LOWFIELD STREET, DARTFORD, KENT
67, HIGH STREET, NORTHFLEET, KENT
177, BROADWAY, BEXLEYHEATH, KENT
127, HIGH STREET, SEVENOAKS, KENT
98, HIGH STREET, TONBRIDGE, KENT

at the Head Office or any Branch of BARCLAYS BANK, LTD., or from Messrs. SEYMOUR, PIERCE & CO., 5, Lothbury, E.C.2.

By Order of the Board,
T. BROWN,
Secretary.

CHIEF OFFICE OF THE COMPANY,
LOWER SYDENHAM, S.E.26.
24th November, 1934.

Gas Markets and Manufactures

Stock Market Report.

[For Stock and Share List, see later page.]

After the recent substantial improvements in gilt-edged securities the profit-taking movement which set in last week was to be expected, and as a consequence some slight reaction in prices inevitable. That no change has come over the general outlook, however, is evidenced by the eagerness with which buyers have sought to take advantage of even fractional falls in value. The reaction in this market was also reflected in the Industrial section, where business was on a reduced scale and quotations generally inclined to weaken.

The hesitancy in the gilt-edged section did not extend to the Gas market, for it will be seen in the Stock and Share List that another large batch of improvements was recorded. The chief feature was a rise of 13 in Harrogate consolidated to 142½, while Imperial Continental ordinary, in which a particularly heavy volume of business was transacted, gained 8 to 217½. It will be noticed that, on the local Exchange, Newcastle 3½% debenture also rose 8 to 101, a price very little below many 4% debenture stocks in the List, though the quotation on the London Exchange remains at 90½. Another interesting feature is the strength of South Metropolitan ordinary, which gained a further 3 to 155½, or 5 points above that of the Company's 6% preference stock which ranks prior to the ordinary stock; but it is possible that investors are anticipating the usual 3½ p.ct. final dividend in March next which gives a return at the current price of 4½% per annum, though the yield for the full year on a 6% dividend basis is £3 17s. 2d.%.

Except in the case of the recently-formed holding companies, there have been comparatively few new issues in the Gas Industry so far this year, so that the recent announcement by the South Suburban Gas Company, particulars of which appear elsewhere in this issue, will be of interest. The Directors are issuing for sale by tender £200,000 4% perpetual preference stock at a minimum of 105%, at which price the yield works out at £3 16s. 2d.%.

Current Sales of Gas Products.

The London Market for Tar Products.

LONDON, *Nov.* 26.

The market for tar products remains steady, with prices at about the following levels:

Pitch, 52s. 6d. per ton f.o.b.

Creosote is firm at 4½d. to 4¾d.

Refined tar, 4d. to 4¼d. per gallon in bulk at makers' works.

Pure toluole, about 2s. 2d.; pure benzole, 1s. 9d. to 1s. 10d.; 95/160 solvent naphtha, 1s. 7d.; and 90/160 pyridine, 6s. to 6s. 3d.—all per gallon naked at makers' works.

Tar Products in the Provinces.

Nov. 26.

The average prices of gas-works products during the week were: Gas-works tar, 21s. 6d. to 26s. 6d.; Pitch—East Coast, 47s. 6d. to 50s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 47s. 6d. to 50s.* Toluole, naked, North, 1s. 6d. to 1s. 8d. Coal-tar crude naphtha, in bulk, North, 6¼d. to 6¾d. Solvent naphtha, naked, North, 1s. 4d. to 1s. 4½d. Heavy naphtha, North, 9¾d. to 10¾d. Creosote, *ex* works, in bulk, North, liquid and salty, 3½d. to 3⅝d.; low gravity, 3½d. to 3⅝d.; Scotland, 3⅝d. to 3¾d. Heavy oils in bulk, North, 3⅝d. to 4¼d. Carbolic acid, 60's, 1s. 8d. to 1s. 9d. Naphthalene, £10 to £11. Salts, 55s. to 75s., bags included. Anthracene, "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 24.

New business continues scarce, but quoted prices are, on the whole, unchanged during the week.

Crude gas-works tar.—Actual value is 30s. to 32s. per ton *ex* works in bulk.

Pitch.—Local makers are holding for 43s. to 44s. per ton f.o.b. Glasgow for export and 42s. 6d. per ton *ex* works in bulk for home trade.

Refined tar is easy at 3d. to 3⅛d. per gallon *ex* works in buyers' packages.

Creosote oil.—There are some large inquiries on the market and prices are steady. B.E.S.A. Specification, 3¾d. to 4d. per gallon; low gravity, 4¼d. to 4½d. per gallon; and neutral oil, 4d. to 4¼d. per gallon; all f.o.r. in bulk.

Cresylic acid.—New business is slow, but prices are unchanged. Pale, 97/99%, is 1s. 2½d. to 1s. 3½d. per gallon; dark, 97/99%, 1s. 0½d. to 1s. 1½d. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon; all *ex* works.

Crude naphtha is only available in small quantities and 4½d. to 5d. per gallon f.o.r., according to quality, is obtainable without difficulty.

Solvent naphtha.—90/160 is 1s. 3d. to 1s. 4d. per gallon and 90/190 grade is round 8d. to 9d. per gallon, according to quantity.

Motor benzole.—1s. 5d. per gallon (nominal).

Pyridines.—90/160 grade is 6s. to 6s. 6d. per gallon, and 90/140 grade 6s. 6d. to 7s. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole	0	9	to	0	9½	per gallon at works
Motor ,,	1	3½	,,	1	4	,, ,, ,,
90% ,,	1	4	,,	1	4½	,, ,, ,,
Pure ,,	1	7½	,,	1	8	,, ,, ,,

New Capital Issues.

South Suburban Gas Company.—An issue of £200,000 of 4% perpetual preference stock is being offered for sale by tender by this Company. The minimum price of issue is £105 per £100 of stock, at which price the yield is £3 16s. 2d. Tenders must be received by 12 o'clock noon on Monday, Dec. 10, 1934.

Barnet District Gas and Water Company.—The Directors of this Company invite tenders (by Monday, Dec. 10) for £25,000 of 4½% preference stock at a minimum price of issue of £114 per £100 of stock, yielding at that price £3 18s. 11d. Further particulars of this call for tenders will be found on another page of this issue.

Contracts Advertised To-Day.

Benzole Recovery Plant.
Cowes Gas Department. [p. 702.]

Boiler (Lancashire), &c.
Chelmsford Gas Department. [p. 702.]

Chimney, &c.
Chelmsford Gas Department. [p. 702.]

Coke and Coal Breaking and Handling Plant.
Cowes Gas Department. [p. 702.]

Stoking Machinery.
Cowes Gas Department. [p. 702.]

Trade Notes.

A Patent Infringement Action.

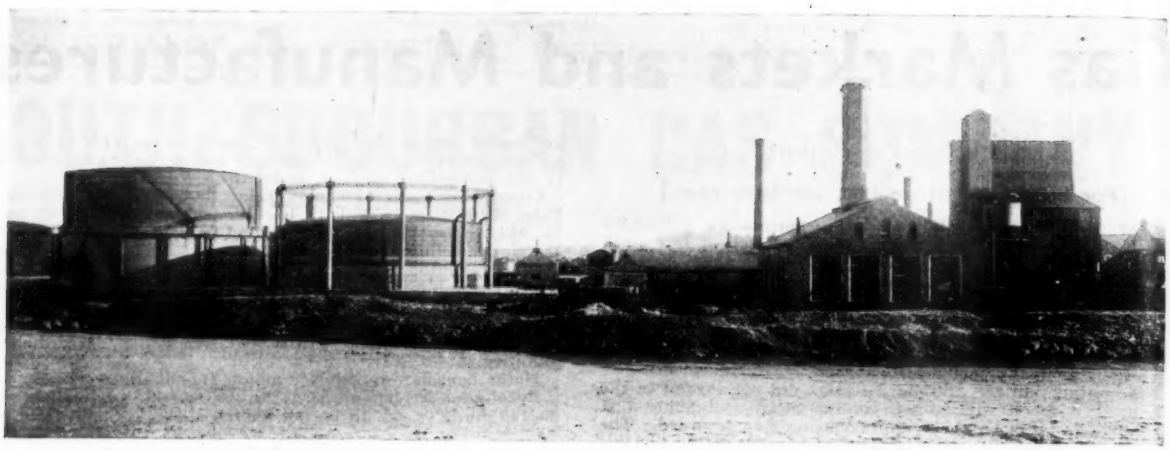
We learn from the Pipe Protection Company, Ltd., of Mossley, that they have recently been unsuccessfully sued in the Copenhagen Courts for damages in respect of alleged infringement of patents in connection with their well known products "Bulldog Swathe" and Parafilm," which are supplied to gas and water undertakings for the protection of pipes against corrosion, electrolysis, &c. Costs, we understand, were awarded against the plaintiffs, Chemieprodukte G.m.b.H., of Berlin.

Overseas Opportunities.

Argentina.

The Commercial Counsellor to H.M. Embassy at Buenos Aires reports that the Argentine State Oilfields are calling for tenders, to be presented in Buenos Aires by Dec. 18, 1934, for the supply of 154,110 metres of weldless steel tubes (mainly black gas threaded) of various sizes. (Ref. G.Y. 14,478.)

An Increase of 161,000 c.ft. in the October output of the Burntisland Gas-Works is reported by Mr. William Brown, Engineer and Manager. During the month 4,051,000 c.ft. of gas was produced and 4,341 gallons of tar were sold, an increase of 21 gallons.



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•

BREEZE · BURNING
PRODUCER EQUIPMENT

•

WASTE · HEAT
RECOVERY PLANT

•

THE WEST
LIP · BUCKET CONVEYOR
WITH AUTOMATIC
FORCED LUBRICATION

•

ALL TYPES OF
COAL AND COKE
HANDLING PLANT

•

THE WEST
BALANCED, RECIPROCATING
COKE GRADER

•

THE WEST · CALVERT
COKE CUTTER

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COAL BREAKERS
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STOCK AND SHARE LIST.

Official Quotations on the London and Provincial Stock Exchanges.

Issue. £	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. Nov. 23.	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
1,551,868	Stk.	Sept. 10	7	7	Alliance & Dublin Ord. ...	135—145	...	135⅝—137⅛
374,000	..	June 25	4	4	Do. 4 p.c. Deb. ...	90—100	...	...
557,655	..	Aug. 13	7	7	Barnet Ord. 7 p.c.	168—173	...	...
300,000	1	Oct. 8	1/9[2]	1/4[2]	Bombay, Ltd.	1⅜—1⅝	...	...
178,480	Stk.	Aug. 13	9½	9½	Bournemouth sliding scale	225—235	...	233—234½
550,050	..	..	7	7	Do. 7 p.c. max. ...	170—175	...	...
439,160	..	..	6	6	Do. 6 p.c. Pref. ...	150—155	+3	153
50,000	..	June 11	3	3	Do. 3 p.c. Deb. ...	87—92	+2	...
262,025	..	..	4	4	Do. 4 p.c. Deb. ...	105—110	...	...
335,000	..	..	5	5	Do. 5 p.c. Deb. ...	125—130	...	...
357,900	..	Aug. 13	7½	7½	Brighton, &c., 5 p.c. Con. ...	175—185	+4½	182—184
540,000	..	..	6[2]	6[2]	Do. 5 p.c. Con. ...	158—163	...	...
196,500	..	..	6	6	Do. 6 p.c. B. Pref.	145—150	+3	...
1,487,500	..	July 9	5	5	Bristol 5 p.c. max.	120—122[a]	...	...
190,490	..	June 11	4	4	Do. 1st 4 p.c. Deb. ...	103—106[a]	...	...
217,870	..	..	4	4	Do. 2nd 4 p.c. Deb. ...	103—106[a]	...	...
338,790	..	..	5	5	Do. 5 p.c. Deb.	123—125[a]	... [2]	...
865,000	..	Sept. 24	8	7	British Ord.	170—175	...	174—177
100,000	..	June 11	7	7	Do. 7 p.c. Pref.	158—163	...	...
120,000	..	..	4	4	Do. 4 p.c. Red. Deb. ...	98—103	...	...
450,000	..	..	5	5	Do. 5 p.c. Red. Deb. ...	107—112	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	2—4	...	...
100,000	10	Nov. 6	4½	4½	Do. 4½ p.c. Pref. ...	4—6	...	...
150,000	Stk.	July 23	4½	4½	Do. 4½ p.c. Deb. ...	90—95	...	...
626,860	..	July 23	6	6	Cardiff Con. Ord.	135—140	...	...
237,860	..	June 11	5	5	Do. 5 p.c. Red. Deb.	107—112	...	...
157,150	..	July 23	6⅔	5	Chester 5 p.c. Ord.	113—118[b]	...	...
98,936	1	Sept. 24	2/-	2/-	Colombo, Ltd. Ord.	1⅞—1⅞	...	...
24,500	1	..	1/4⅜	1/4⅜	Do. 7 p.c. Pref. ...	19/6—21/6	...	...
609,204	1	Sept. 24	/11'48	/11'48	Colonial Gas Assn. Ltd. Ord.	19/6—21/6	...	...
296,058	1	..	1/8'80	1/8'80	Do. 8 p.c. Pref.	24/6—26/6	...	...
1,775,005	Stk.	July 23	6½	5	Commercial Ord.	122—127	+2	125½—126½
475,000	..	June 11	3	3	Do. 3 p.c. Deb. ...	88—92	...	90
286,344	..	Aug. 13	5	5	Do. 5 p.c. Deb. ...	122—127	...	...
807,560	..	Aug. 13	7	7	Croydon sliding scale ...	165—170	...	...
569,590	..	..	5	5	Do. max. div.	112—117	+2	...
620,385	..	June 25	5	5	Do. 5 p.c. Deb.... ...	123—128	...	...
542,270	..	Aug. 13	10	7	Derby Con.	192—197[e]	...	...
55,000	..	June 25	4	4	Do. 4 p.c. Deb.	100—105[e]	...	...
209,000	..	Aug. 13	5	5	East Hull Ord. 5 p.c. ...	113—118	+5½	116—115½
181,625	..	Aug. 13	6	6	East Surrey Ord. 5 p.c. ...	137—142	...	...
175,809	..	June 11	5	5	Do. 5 p.c. Deb. ...	120—125	...	...
1,002,180	..	Sept 10	17	15	European, Ltd.	122—127	...	123½—124½
19,849,768	..	Aug 13	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	28/9—29/9/	...	29/-—29/4½
2,600,000	..	..	3½	3½	Do. 3½ p.c. max.	93—96	+1	94½—95⅜
4,477,106	..	..	4	4	Do. 4 p.c. Con. Pref. ...	108—111	...	109½—110½
6,102,497	..	May 28	3	3	Do. 3 p.c. Con. Deb. ...	90—92	...	90—92
3,642,770	..	..	5	5	Do. 5 p.c. Red. Deb. ...	118—121	...	120½—121
3,500,000	..	..	4½	4½	Do. 4½ p.c. Red. Deb. ...	117—120	+1	119½—120
270,466	..	Aug 13	6	6	Harrogate New Cons. ...	140—145	+13	140⅞
140,000	1	Sept 24	1/7½	1/7½	Hongkong & China, Ltd. ...	1⅛—1⅜*	...	29/9—30/-
213,200	Stk.	Aug. 13	6	6	Hornsey Con. 3½ p.c. ...	137—142	...	...
5,600,000	..	Oct. 22	14	10	Imperial Continental Cap.	215—220	+8	210—220½
223,180	..	July 23	3½	3½	Do. 3½ p.c. Red. Deb.	92—97	...	94½
285,242	..	Aug. 13	8½	8½	Lea Bridge 5 p.c. Ord. ...	196—200	...	195
2,167,410	..	Aug. 13	6	6	Liverpool 5 p.c. Ord. ...	140—142[b]	+½	...
245,500	..	June 11	5	5	Do 5 p.c. Red. Pref. ...	105—110[b]	...	...
306,083	..	July 16	4	4	Do. 4 p.c. Deb. ...	102—104[b]	...	...
11,751	..	Aug. 27	10	8	Maidstone 5 p.c. Cap. ..	188—198	...	...
63,480	..	June 25	3	3	Do. 3 p.c. Deb. ...	84—89	...	...
75,000	..	May 28	†10	†10	Malta & Mediterranean ...	200—210	...	...
392,000	—	Oct 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	100—103	...	...
231,978	Stk.	Aug. 13	5	5	M. S. Utility "C." Cons. ...	113—118	...	...
818,657	..	..	4	4	Do. 4 p.c. Cons. Pref.	100—105	+2	102
360,075	..	June 11	4	4	Do. 4 p.c. Deb. ...	102—107	+2	...
148,955	..	..	5	†5	Do. 5 p.c. Deb. ...	122—127	...	...
125,000	—	July 2		11/8	Do 3½ p.c. Rd. Rg.Bds.	97—100	...	...
675,000	..	May 28	†6	†13	Montevideo, Ltd.	60—65	...	...
2,061,315	..	Aug. 13	6½	6	Newcastle & Gateshead Con.	26/9—26/9d[f]	—/3	...
682,856	..	..	4	4	Do. 4 p.c. Pref. ...	105—107[d]	...	...
776,706	..	June 11	3½	3½	Do. 3½ p.c. Deb. ...	100—102	+8	...
277,285	..	May 7	5	5	Do. 5 p.c. Deb. '49 ...	105—107[d]	...	...
274,000	..	Aug. 13	5	5	Newport (Mon.) 5 p.c. max.	106—108[a]	...	...
204,940	..	Aug. 13	7½	7½	North Middlesex 6 p.c. Con.	160—167	...	...
396,160	..	Aug. 13	5	5	Northampton 5 p.c. max. ...	107—112	...	...
800,000	..	Nov. 5	†7	†9	Oriental, Ltd.	166—171*	...	...
416,617	..	June 11	8	8	Plym'th & Stonehouse 5 p.c.	183—188	+5	183—187
504,416	..	Aug. 13	6	6	Portsm'th Con.Stk. 4 p.c.Std	182—187	+5	184
241,446	..	..	5	5	Do. 5 p.c. max. ...	110—115	+5	...
114,000	..	July 23	5	5	Preston 5 p.c. Pref.	101—106	...	...
1,736,968	Stk.	Aug 27	6	6	Sheffield Cons.	141—143[e]	...	...
95,000	..	July 9	4	4	Do. 4 p.c. Deb.	100—104[e]	...	...
133,201	..	Aug. 13	5	8½	Shrewsbury 5 p.c. Ord. ...	154—159	+5	...
90,000	10	May 28	14	13	South African	3—4	+½	...
927,177	1	Sep. 10	1/3[2]	1/2[3]	South-East'n Gas Cn.Ld. Ord.	30/6—32/6	+/6	31/9—32/-
786,061	1	..	-/10½	-/10½	Do. 4½ p.c. Red.Cum.Pref.	22/6—23/6	...	23/1½—23/4½
450,000	Stk.	Aug. 13	7¼/4	4	Do. 4 p.c. Red. Deb. ...	102—105	...	...
6,709,895	..	Aug. 13	7	5	South Met. Ord.	153—158	+3	154—157½
1,135,812	..	..	6	6	Do. 6 p.c. Irred. Pf.	148—153	...	151—152
850,000	..	..	4	4	Do. 4 p.c. Irred. Pf.	107—110	...	109½—110
1,895,445	..	June 25	3	3	Do. 3 p.c. Deb. ...	90—93	+2	91—93
1,000,000	..	July 9	5	5	Do. 5 p.c. Red. Deb.	117—121	+2½	119
209,320	..	Aug. 13	8½	8½	South Shields Con.	183—185[d]	...	...
1,543,795	..	July 9	6	6	South Suburban Ord. 5 p.c.	140—145	...	...
512,895	..	..	5	5	Do. 5 p.c. Pref.	124—129	...	126½—127½
300,000	..	..	4	4	Do. 4 p.c. Pref.	102—107	...	...
868,837	..	June 11	5	5	Do. 5 p.c. Deb.	125—130	...	126—126½
100,000	..	..	4	4	Do. 4 p.c. Deb.	108—113	+6	108½
647,740	..	Aug. 13	5	5	Southampt'n Ord. 5 p.c. max.	118—123	+1	120½—122½
121,275	..	June 11	4	4	Do. 4 p.c. Deb.	102—107	...	...
350,000	..	Aug. 13	5½	5½	Swansea 5½ p.c. Red. Pref.	113—118	...	...
200,000	..	June 11	6½	6½	Do. 6½ p.c. Red. Deb.	102—107	...	106½
1,076,490	..	Aug. 13	6½	6½	Tottenham and District Ord.	163—168	+5½	162—164
409,835	..	..	5½	5½	Do. 5½ p.c. Pref. ...	130—135	...	...
62,285	..	..	5	5	Do. 5 p.c. Pref. ...	122—127	...	...
199,005	..	June 11	4	4	Do. 4 p.c. Deb. ...	102—107	...	...
349,110	..	Aug. 13	7	7	Uxbridge, &c., 5 p.c. ...	165—170	...	167
88,330	..	..	5	5	Do. 5 p.c. Pref. ...	124—129	...	...
1,326,700	..	Aug. 13	7	7	Wandsworth Consolidated	165—170	...	164½—166
1,371,373	..	..	5	5	Do. 5 p.c. Pref.	124—129	...	126—126½
1,317,964	..	June 11	5	5	Do. 5 p.c. Deb.	125—130	+1	...
208,300	..	..	...	26/8	Do. 4 p.c. Deb.	107—110	+3	...
158,400	..	Aug. 13	6[a]	5	Winchester W.& G.5 p.c.Con.	120—125	...	...

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock. *g.*—Paid £8, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year.

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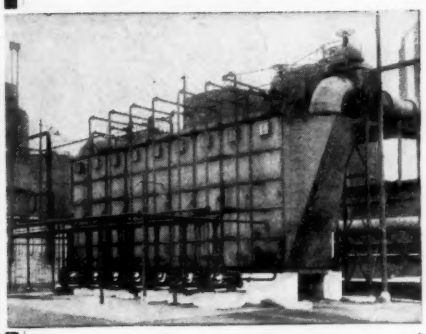

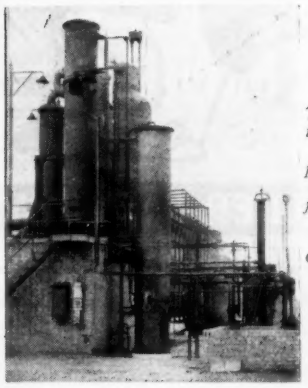

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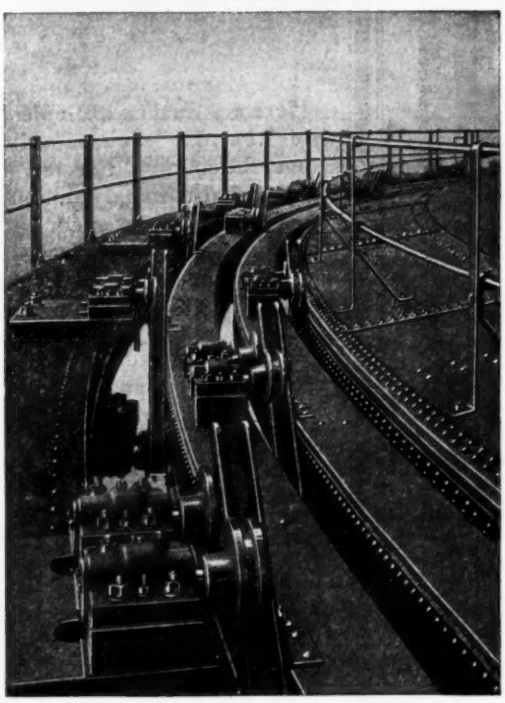

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